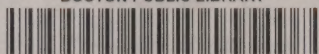
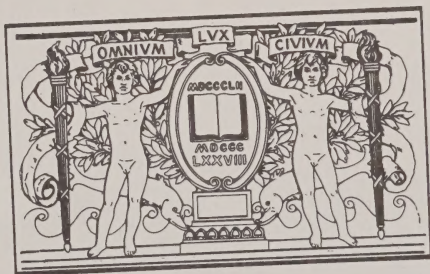


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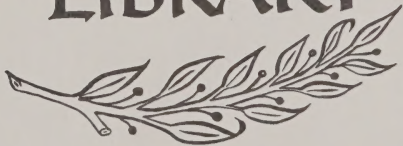


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ANNUAL REPORTS

OF THE

BOARD OF HARBOR COMMISSIONERS

OF THE

Commonwealth of Massachusetts,

(FIRST TO FIFTH, INCLUSIVE:)

ALSO,

ACTS AND RESOLVES OF THE LEGISLATURE

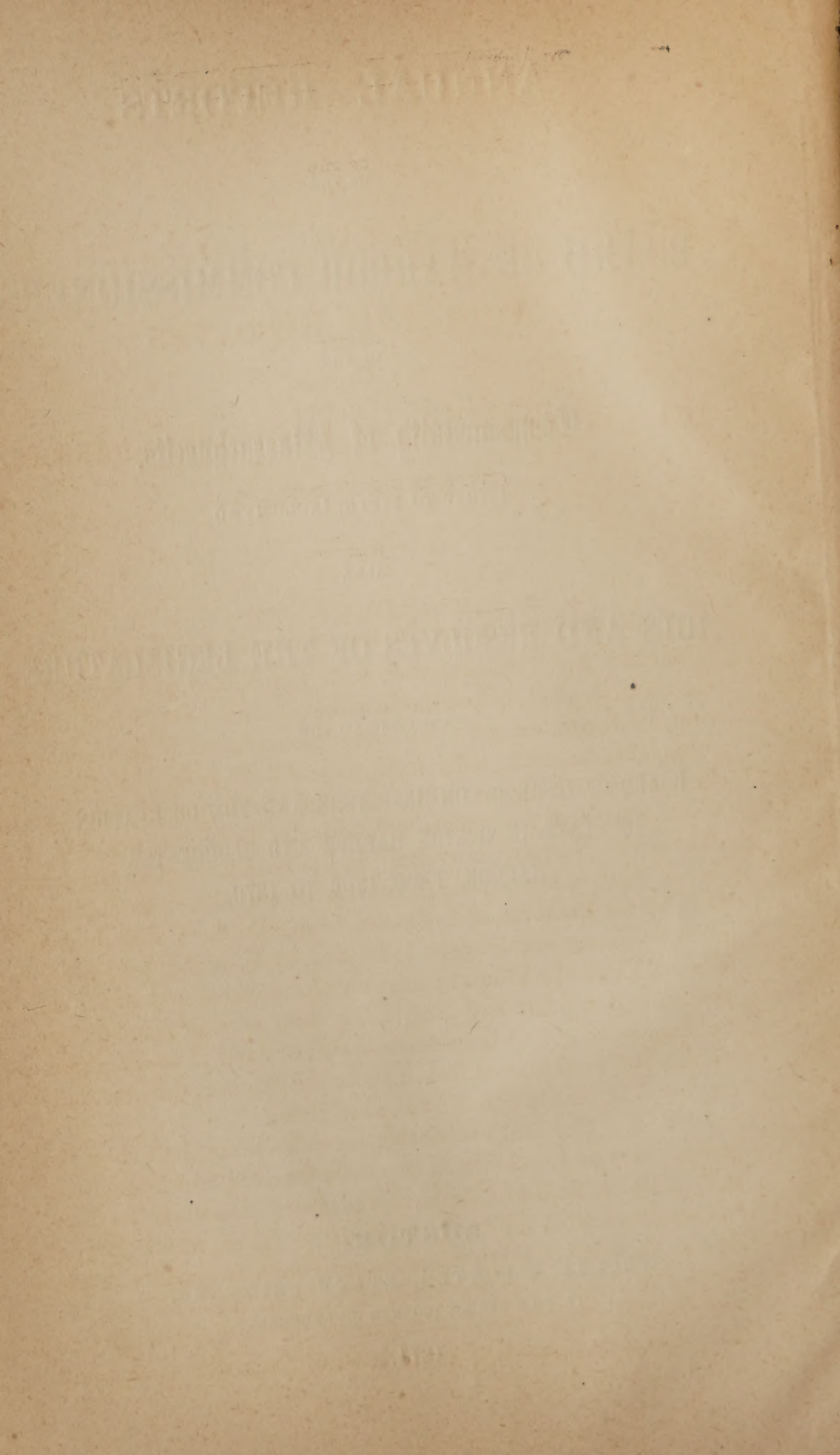
RELATING TO THE

BOARD OF HARBOR COMMISSIONERS AND THE OCCUPATION
OF FLATS IN BOSTON HARBOR AND GLOUCESTER
HARBOR, FROM 1866 TO 1870.

BOSTON:

WRIGHT & POTTER, STATE PRINTERS,
79 MILK STREET (CORNER OF FEDERAL).

1871.



ACTS AND RESOLVES

RELATING TO

HARBOR COMMISSIONERS AND CERTAIN HARBORS.

1866-1870.

[Chapter 149, Acts of 1866.]

AN ACT TO ESTABLISH A BOARD OF HARBOR COMMISSIONERS.

SECTION 1. The governor, with the advice and consent of the council, shall, before the first day of July next, appoint five competent persons, who shall constitute a board of harbor commissioners, and who shall hold their offices from the dates of their respective appointment, and for the terms of one, two, three, four and five years, respectively, from the first day of July next. The governor shall, in like manner, before the first day of July in every year, appoint a commissioner to continue in office for the term of five years from said day; and in case of any vacancy occurring in the board, by resignation or otherwise, shall, in the same manner, appoint a commissioner for the residue of the term, and may in the same manner remove any commissioner. And the compensation of each of said commissioners shall not exceed five dollars per day for time actually employed in the service of said commission.

SECT. 2. The board of harbor commissioners shall have the general care and supervision of all the harbors and tide-waters, and of all the flats and lands flowed thereby, within the Commonwealth, except the back bay lands, so called, in the city of Boston, in order to prevent and remove unauthorized encroachments and causes of every kind which are liable to interfere with the full navigation of said harbors, or in any way injure their channels, or cause any reduction of their tide-waters, and

in order to protect and develop the rights and property of the Commonwealth in said flats and lands. They may, from time to time, make such surveys, examinations and observations as they may deem necessary in any harbor for said purpose, and employ for these purposes competent engineers, and also employ such clerical and other assistance as they may think necessary. They shall inquire as to the riparian rights of the owners of land on the northerly shore of South Boston, both as to the flats lying between said shore and the channel, and the rights of navigation over the same; and to ascertain whether said rights can be extinguished or harmonized with rights claimed by the Commonwealth; to prepare a plan for the improvement of said flats, and report to the next legislature. They shall have an office in Boston, where the maps, charts, and plans connected with the harbors, records of all their doings, and all documents relating to their business, shall be kept.

SECT. 3. Whenever in the judgment of the said board of commissioners the public good requires, they may proceed to prescribe harbor lines in any of the harbors of this Commonwealth, beyond which no wharf, pier or other structure shall be extended into such harbor, and shall report the same for the consideration of the legislature at its next session: *provided, however,* that said commissioners before drawing any such line shall appoint a convenient time and place for the hearing of all parties interested, and shall give notice thereof by publication three weeks successively in two or more newspapers, one of which is published in Boston, and one in the county where such harbor is situated, the first publication to be at least thirty days before the time of hearing.

SECT. 4. All persons that have been or may be authorized by the legislature to build over tide-waters any bridge, wharf, pier or dam, or to fill any flats, or to drive any piles below high-water mark, who have not already begun such work, shall, before beginning it, give written notice to the harbor commissioners of the work they intend to do, and submit plans of any proposed wharf or other structure, and of the flats to be filled, and of the mode in which the work is to be performed; and no such work shall be commenced until the plan and mode of performing the same shall be approved in writing by a majority of the said harbor commissioners. And the said commissioners

shall have power to alter the said plans at their discretion, and to prescribe the direction, limits, and mode of building the wharves and other structures, to any extent that does not diminish or control the legislative grant; and all such works shall be executed under the supervision of the commissioners. The amount of tide-water displaced by any structure or filling of flats hereafter authorized as aforesaid, shall be ascertained by the harbor commissioners, and they shall, in all cases affecting the harbor of Boston, and in cases affecting other harbors, if they shall deem it necessary, require the parties making the same to make compensation therefor, either by excavating in some part of the same harbor where the work is performed, including tide-water channels between high and low water mark, to such an extent as to create a basin for as much tide-water as may be displaced by such structure or filling of flats, and the same shall be done under their direction, or by paying in lieu of performing the work of dredging to restore the displaced tide-water a sufficient sum of money for making such compensation, or by improving the harbor in any other mode to the satisfaction of the commissioners; and all money thus paid shall be paid into the treasury of the Commonwealth, and be reserved as a compensation fund for the harbor where such compensation is to be made, and used for that purpose under the direction of the commissioners: *provided*, that all dredging made for purposes of such compensation for displaced tide-water shall in no wise injure any existing channels, but as far as practicable shall be directed towards their permanent improvement.

SECT. 5. All erections and works hereafter made without authority from the legislature, or in any manner not sanctioned by the board of harbor commissioners, where their direction is required as herein before provided, within tide-waters flowing into or through any harbor, shall be considered a public nuisance and liable to indictment as such. The board of harbor commissioners shall have power to order suits on behalf of the Commonwealth to prevent or stop, by injunction or otherwise, any such erection or other nuisance in the tide-waters which flow into or through any harbor in the Commonwealth, or thus to prevent or stop the removal of any material from any bar or breakwater of any such harbor; and the attorney-general and

district-attorneys within their districts shall commence and conduct such suit.

SECT. 6. The harbor commissioners are authorized and empowered, whenever they deem it necessary, to apply to congress for appropriations for protecting and improving any harbor in the Commonwealth.

SECT. 7. No contracts shall be made and no acts done by said commissioners which involve the payment of any money from the treasury of the Commonwealth, except as herein provided, without an appropriation expressly made by the legislature for that purpose. They shall keep an account of their actual services and expenses, to be allowed by the governor and council.

SECT. 8. The commissioners shall report in print to the legislature annually, on or before the tenth day of January, their doings during the year preceding, and shall recommend such legislation as they deem necessary for the preservation and improvement of the harbors and the promotion of the interest of the Commonwealth connected therewith: and whenever they shall propose any plan for the improvement of the flats in the harbor of Boston, or to alter any harbor line in the same, they shall furnish to the legislature a copy of the report of the United States commissioners upon the harbor of Boston. [*April 12, 1866.*]

[Chapter 81, Resolves of 1866.]

RESOLVES IN RELATION TO BOSTON HARBOR AND THE COMMONWEALTH
FLATS THEREIN.

Resolved, That the plan recommended by the commissioners on harbors and flats in their fourth report, presented at the present session of the legislature, for the occupation of the flats owned by the Commonwealth in Boston harbor, lying northerly of South Boston and easterly of that part of Boston which lies between Long wharf and Arch wharf, is approved and adopted by this legislature; and that the same, when executed, will greatly improve the harbor of Boston, increase the commercial prosperity of the city, and benefit the Commonwealth.

Resolved, That the harbor commissioners be and they hereby are authorized and directed to ascertain and report to the legis-

lature at its next session, on or before the fifteenth day of January next, the probable cost of the several sections of the outer wall mentioned in said report and laid down on the plan annexed to it, and of building the wharves and filling the flats of the Commonwealth, as laid down on said plan ; the expense of dredging in Fort Point Channel, which will be required by the proposed changes therein, and of grading streets and building sewers over and through said flats ; also, the probable expense of making compensation for the tidal water to be shut out by the filling of said flats ; also to ascertain and report on what terms and conditions the said walls, wharves, streets, sewers, or any parts thereof, can be built by any corporations or individuals, and on what terms and conditions the said flats, or any parts thereof, can be filled, and on what terms and conditions the said flats or any parcels thereof, can be sold to any corporations or individuals, either for money or for filling other portions of said flats, and in what places and manner compensation for the tide-water shut out by filling said flats can best be made, and on what terms and conditions persons whose lands are to be affected by said compensation, will give authority to make the same ; also, on what terms and conditions the rights and interests of the riparian proprietors in South Boston and others, can be harmonized with the proposed occupation and improvement of said flats ; also to report any other matters which said commissioners consider as material in regard to the occupation of said flats ; the said commissioners in all plans and proposals submitted by them, always regarding the protection and improvement of the harbor of Boston as of paramount importance, in any intended occupation of said flats.

Resolved, That the harbor commissioners be authorized to contract with the city of Boston for the construction of the whole or any part of the Eastern Avenue, and to make payment therefor by conveying such portions of the flats belonging to the Commonwealth, northerly of the South Boston shore, as shall be deemed necessary for the said purpose : *provided*, that compensation for all tide-water excluded by carrying into effect these resolves shall be duly made as provided in the act to establish a board of harbor commissioners : *provided*, that the terms of any contract and conveyance shall be subject to the approval of the governor and council ; and *provided*, that no

money shall be paid from the treasury of the Commonwealth; *provided also*, that nothing shall be done under this resolve which shall conflict with the plan of the South Boston flats accompanying the report of the commissioners on harbors and flats of the Commonwealth of Massachusetts, presented to the legislature on the sixth day of January in the year eighteen hundred and sixty-six, or which shall conflict with the reports of the United States commissioners. [*Approved, May 18, 1866.*]

[Chapter 354, Acts of 1867.]

AN ACT FOR THE IMPROVEMENT OF THE HARBOR OF BOSTON AND THE COMMONWEALTH'S FLATS THEREIN.

Be it enacted, &c., as follows:

SECTION 1. The board of harbor commissioners is hereby authorized and empowered to contract with any responsible person or persons for the construction of a continuous sea-wall upon the flats of the Commonwealth in Boston harbor, as hereinafter described. They are also authorized and empowered to contract for the dredging and deepening of such flats as are in front of said sea-wall, for the purpose of filling so much of the flats of the Commonwealth as may be included within a line behind said wall, and parallel therewith, such filling to be extended inwardly only so far as may be necessary to support the sea-wall, and upon the following terms and conditions. The sea-wall shall be commenced at or near the point of intersection of the line marked A on the commissioners' line, established by chapter three hundred and eighty-five of the acts of the year one thousand eight hundred and fifty-three, with the easterly line of Fort Point Channel, and shall be built from that point, and within and parallel with the exterior line to the point known as Slate Ledge, as laid down on the plan for the occupation of the flats owned by the Commonwealth in Boston harbor, approved by the legislature in the eighty-first chapter of the resolves of the year one thousand eight hundred and sixty-six, or upon any modifications of said plan hereafter made.

SECT. 2. The board of harbor commissioners shall have authority to modify the line between point A and the point where

the curve strikes the exterior line recommended by the United States commissioners on Boston harbor, and the sea-wall shall be built in accordance with the line so modified.

* [SECT. 3. An engineer shall be appointed by the governor, whose duty it shall be to prepare plans and specifications for proposals and contracts for the construction of said sea-wall, dredging and filling. He shall consult with the harbor commissioners, and shall locate said wall and decide upon the amount of dredging and width of filling behind the sea-wall, having due regard for economy and strength, as well as the proper direction of the currents in Boston harbor. All plans and specifications for contracts prepared by said engineer, shall be submitted to the governor and council; and if approved by them, the commissioners shall advertise for proposals for the work; which proposals shall be submitted to the governor and council; and when any proposals are approved and accepted by them, the commissioners shall sign such contract as the representatives of the Commonwealth. The engineer shall have the superintendence of all the works to be done in pursuance of this act, under the direction of the board of harbor commissioners. The compensation of the engineer shall be fixed by the governor and council.]

SECT. 4. All license and authority to the Boston Wharf Company to extend their wharf over so much of the territory referred to in section one of chapter four hundred and fifty-five of the acts of the year eighteen hundred and fifty-five, as lies between lines marked A and B, described in chapter three hundred and eighty-five of the acts of the year eighteen hundred and fifty-three, are hereby revoked, except so far as substantial structures may have been erected by said company thereon.

* [SECT. 5. It shall be the duty of the engineer appointed under this act, to cause hydrographical surveys to be made from time to time, for the purpose of determining the effect upon the harbor of the structures and filling in connection with the dredging herein authorized, and in case it shall appear that the same injuriously affect the harbor, by reason of the displacement of tide-water, compensation shall be made therefor, in such

* Sections 3 and 5 of this Act are repealed by section 9, chapter 323 of the Acts of the year 1863.

manner and to such an extent as the legislature shall hereafter determine.]

SECT. 6. For the works to be done under this act, the sum of two hundred thousand dollars is hereby appropriated, and shall be allowed and paid.

SECT. 7. This act shall take effect upon its passage. [*Approved June 1, 1867.*]

[Chapter 190, Acts of 1867.]

AN ACT RESPECTING THE OCCUPATION OF FLATS IN THE HARBOR OF GLOUCESTER.

Be it enacted, &c., as follows:

SECTION 1. All persons owning flats in the harbor of Gloucester are hereby authorized to extend and maintain wharves upon the same, or to fill up and build upon the same, but not beyond the harbor lines there now established.

SECT. 2. All persons owning flats in the harbor of Gloucester whose outer lines of title are the low-water mark, or one hundred rods below the high-water mark, may extend and maintain wharves over any flats of the Commonwealth that may lie between their said outer lines and the harbor lines there now established, but in such manner that all persons affected by this grant may have equal proportionate rights of advancing to or toward the said harbor lines.

SECT. 3. All things which may at any time be done under this grant, shall be subject to the determination and approval of the board of harbor commissioners, as provided in section four of chapter one hundred and forty-nine of the acts of the year eighteen hundred and sixty-six.

SECT. 4. If the harbor lines of Gloucester shall at any time be removed nearer to the high-water mark, this grant shall be construed to apply only to such new lines, except so far as valuable structures may have been actually and in good faith built under the same.

SECT. 5. When in any previous grant of a right to extend and maintain a wharf in Gloucester harbor, liberty has been given to lay vessels at the sides or end of such wharf, the liberty so granted shall not be construed as a grant of any private

right in or over the flats of any other person, or of any private right in or over the flats of the Commonwealth not revocable at any time by the legislature.

SECT. 6. The grants made by this act are revocable by the legislature at any time, except so far as valuable structures may have been actually and in good faith built under the same.

SECT. 7. This act shall take effect upon its passage. [*Approved April 30, 1867.*]

[Chapter 326, Acts of 1868.]

AN ACT IN ADDITION TO "AN ACT FOR THE IMPROVEMENT OF THE HARBOR OF BOSTON AND THE COMMONWEALTH'S FLATS THEREIN."

SECTION 1. The harbor commissioners are hereby authorized to contract in the name of the Commonwealth with any person or persons, or with the city of Boston, for the filling of any portion of the lands or flats in Boston harbor which lie northerly of South Boston and easterly of Fort Point Channel, and within the exterior line laid down on the plan for the occupation of the flats owned by the Commonwealth in Boston harbor, approved by the legislature in the eighty-first chapter of the resolves of the year eighteen hundred and sixty-six, and for building wharves, docks, sea-walls, basins, streets, bridges or sewers, and for dredging or doing any work upon or in relation to said flats, and to pay for the same by conveyances of any portion of said flats, or the granting of any rights or privileges therein, and for laying out and building streets and sewers to and over said flats or any part thereof, reserving and laying out channels; and they may authorize any corporations or persons to lay and use railroad tracks over any parts of said flats, for the purpose of transporting materials for filling up the said flats, and of any other work in relation thereto, and shall have full power to determine and settle, by agreement, arbitration or process of law, the relative rights and interests of the Commonwealth and all other parties in and to and over said flats and parts thereof; and said commissioners shall have power to enter into any contracts in regard to the occupation and improvement of said flats which said commissioners think best: *provided*, that every conveyance made and the terms thereof, every

contract entered into, every authority given for laying railroad tracks and otherwise, every plan for the occupation of said flats, and building docks, sea-walls, basins, wharves, streets and sewers thereon, adopted by said commissioners, shall be submitted to the governor and council, and shall not be binding on the Commonwealth, and shall not have any force or effect until the same have been approved by the governor and council.

SECT. 2. Said commissioners may make any contract which they think judicious, with any of the riparian owners in South Boston, and with the Boston Wharf Company, for the purchase or exchange of lands or flats, and they shall have full authority to release for money or other valuable consideration, upon such terms and conditions as they shall deem fit, and convey by deed, with warranty or otherwise, to be duly executed by them in behalf of the Commonwealth, the right, title and interest of the Commonwealth in the whole or any part of said lands or flats; but all sales of lands or flats, unless otherwise ordered by the governor and council, shall be by public auction, and the manner, terms and conditions of such sales shall be prescribed by the governor and council.

SECT. 3. The sea-wall authorized to be erected under chapter three hundred and fifty-four of the acts of the year eighteen hundred and sixty-seven may be commenced at any point on Fort Point Channel considered expedient by the commissioners, and shall be built on the exterior line laid down on the plan designated in said act, as subsequently modified, or within said line at a distance not exceeding fifty feet therefrom. Said wall may be constructed with openings in the same, filled with sheet pilings or otherwise, between such points as said board shall determine. And said commissioners may erect a suitable temporary bulkhead of wood to retain the dredged material, previous to the construction of said wall, at such a distance in the rear thereof as will not interfere with the construction of said wall and the docks and wharves connected therewith. And the commissioners may use the unexpended balance of the appropriation made in the acts aforesaid for these purposes.

SECT. 4. All contracts for filling section one, as shown upon plan number one, dated the twelfth day of December, in the year eighteen hundred and sixty-seven, annexed to the report of the committee on the Commonwealth flats, near South Bos-

ton, appointed under chapter ninety-three of the resolves of the year eighteen hundred and sixty-seven, shall require the whole of that portion of the upper harbor of Boston, colored red upon plan number two, annexed to said report, to be dredged, as nearly as practicable, to the depth of twenty-three feet below mean low-water thereon, and the materials thus obtained to be used in filling said section one. And all contracts for filling sections two and three, as shown upon said plan number one, shall require a portion of said upper harbor to be dredged in the same manner and to the same depth as aforesaid, and the materials thus obtained to be used in filling said sections two and three; and the number of cubic yards of material so required to be dredged and used in filling said sections two and three, respectively, shall bear the same proportion to the respective areas of said sections two and three that the number of cubic yards herein required to be dredged from said locality, colored red, shall bear to the area of said section number one. All said contracts for filling said sections shall require the additional materials therefor to be dredged from the reserve channel, as shown upon said plan number two, and also from such other parts of the harbor or taken from such other sources as said commissioners may deem expedient. And the dredging so done in said upper harbor shall be full compensation for the tide-water displaced by the work authorized under this act: *provided, however*, if it shall appear from hydrographical and physical surveys that injury to the harbor has resulted from the work herein authorized, then such injury shall be repaired, by dredging or otherwise, in such manner and to such an extent as the legislature shall hereafter determine.

SECT. 5. All money received from the sale of lands and flats or otherwise, under this act, shall be paid into the treasury of the Commonwealth, and shall be applied to the sinking fund as provided for by section three of chapter one hundred and twenty-two of the acts of the year eighteen hundred and sixty-five.

SECT. 6. The city of Boston is hereby authorized to build and lay out as a public street, Eastern Avenue, with a bridge over Fort Point Channel, having suitable draws, said avenue and bridge to be located and constructed at such places and upon such plans and upon such terms and conditions as the har-

bor commissioners may make, the same to be subject to the approval of the governor and council.

SECT. 7. All plans and specifications for the improvement of the flats and for work in connection therewith, and all contracts made in carrying out the authority given by this act shall be subject to the approval of the governor and council.

SECT. 8. Nothing herein contained shall authorize said commissioners, by any stipulation or contract, to require the payment of any money from the treasury of the Commonwealth except as provided in the third section of this act.

SECT. 9. Chapter ninety-three of the resolves of the year eighteen hundred and sixty-seven, also sections three and five of the three hundred and fifty-fourth chapter of the acts of the year eighteen hundred and sixty-seven are hereby repealed.

SECT. 10. This act shall take effect upon its passage. [*Approved June 9, 1868.*]

[Chapter 446, Acts of 1869.]

AN ACT TO AUTHORIZE THE PURCHASE OF CERTAIN LANDS FOR THE BENEFIT OF THE FLATS OF THE COMMONWEALTH IN BOSTON HARBOR.

SECTION 1. For the purpose of making more available for sale the flats of the Commonwealth, in the harbor of Boston, and perfecting the improvement of the same, the powers conferred on the harbor commissioners by section two of chapter three hundred and twenty-six of the acts of the year eighteen hundred and sixty-eight, are hereby so far enlarged that said commissioners are authorized to purchase for, and in the name of the Commonwealth, any lands and flats on the northerly shore of South Boston, lying westerly of the easterly line of E Street extended, and extinguish by purchase any claims to title in such lands and flats; and they shall have full power to determine and settle by agreement, arbitration or process of law the rights and interests which the Commonwealth has or shall acquire in any of said lands and flats and any parts thereof. Such lands and flats shall be subject to the same provisions of sections one, two, four and seven of said chapter, as the lands and flats in Boston harbor described in said first section, and

the harbor commissioners shall have the same powers in relation thereto.

SECT. 2. Section one of the South Boston flats described in the fourth section of said act, is hereby enlarged so as to include the lands and flats acquired under this act, and the harbor commissioners may authorize the occupation and improvement of said section one without any reservation for a channel, and without requiring any dredging from a reserve channel.

SECT. 3. All purchases and contracts made under the provisions of this act shall be subject to the approval of the governor and council, and no obligation shall be assumed in behalf of the Commonwealth as a consideration for any such purchase beyond that of providing for the filling so much of the flats acquired under this act as shall be sufficient for a suitable street along the southerly line of such flats whenever the flats from the shore to such line shall have been filled by the riparian owners.

SECT. 4. There shall be allowed and paid out of the treasury of the Commonwealth a sum not exceeding three hundred thousand dollars, to be expended in making the purchases herein authorized, and the same is hereby appropriated.

SECT. 5. The net proceeds of the sales of all lands purchased under authority of this act, and of all lands contained in section one of the South Boston flats referred to in the fourth section of chapter three hundred and twenty-six of the acts of the year eighteen hundred and sixty-eight, after deducting therefrom all sums of money paid for the purchase of the lands acquired under authority of this act, with interest, shall be paid into the sinking funds established by chapter three hundred and thirteen of the acts of the year eighteen hundred and sixty-four, and chapter one hundred and twenty-two of the acts of the year eighteen hundred and sixty-five.

SECT. 6. For the purposes of this act, the treasurer and receiver-general, under the direction of the governor and council, is hereby authorized to issue scrip or certificates of debt, in the name and on the behalf of the Commonwealth, and under his signature and the seal of the Commonwealth, to an amount not exceeding three hundred thousand dollars, and for a term not exceeding five years, the principal and interest payable in gold in the city of Boston. Said scrip shall be issued in the

form of registered bonds, or in the form of certificates of debts, with interest coupons attached, as the governor and council shall decide, and shall bear an annual interest of five per cent., payable semi-annually on the first days of January and July in each year, and shall be countersigned by the governor, and shall be deemed a pledge of the faith and credit of the Commonwealth, redeemable at maturity ; and shall be sold and disposed of in such manner, and at such times, and in such pieces and amounts, as the governor and council shall deem for the best interests of the Commonwealth.

SECT. 7. This act shall take effect upon its passage. [*Approved June 22, 1869.*]

Commonwealth of Massachusetts.

FIRST ANNUAL REPORT

OF THE

Board of Harbor Commissioners.

JANUARY, 1867.

BOSTON:
WRIGHT & POTTER, STATE PRINTERS,
No. 4 SPRING LANE.
1867.

CONTENTS.

	Page.
Report of the Board of Harbor Commissioners,	5
Proposed Contract between the City and the State concerning the occupation of the South Boston Flats,	12
Orders adopted by the City Council of Boston,	18
Communication from the Advisory Council,	20
Copy of the Petition to Congress,	24



Commonwealth of Massachusetts.

*To the Honorable Senate and House of Representatives of the
Commonwealth of Massachusetts.*

The Board of Harbor Commissioners, established by Chapter 149 of the Acts of 1866, respectfully submit their first annual

R E P O R T :

The members of the Board were appointed on the 29th of June, and organized on the 9th of July. The Board were fortunate enough to secure, as an advisory council, Rear Admiral Charles H. Davis, superintendent of the United States Naval Observatory, Major-General Richard Delafield, of the United States Corps of Engineers, Major-General A. A. Humphreys, Chief Engineer of the United States, and Henry Mitchell, Esq., assistant in the United States Coast Survey. The advice of the council, in regard to the protection and improvement of our harbors—especially Boston Harbor—rendered as it is gratuitously, has been and will be of the highest value and importance. Mr. Mitchell, as the representative of the council, has been able to attend most of the meetings of the Board, and we are deeply indebted to him for his aid.

We have engaged, as engineer of the Board, Albert Boschke, Esq., whose services on the coast survey, and in the survey of the harbor of Boston, as well as his other qualifications, specially adapt him for the situation. His work has been performed in the most satisfactory manner. We have chosen Mr. James M. Bugbee clerk of the Board.

SOUTH BOSTON FLATS.

The Commissioners were directed by a Resolve passed the 18th of May, 1866, “to ascertain and report to the

legislature at its next session, on or before the 15th day of January next, the probable cost of the several sections of the outer wall mentioned in the Fourth Report of the Commissioners on Harbors and Flats, and laid down on the plan annexed to it, and of building the wharves and filling the flats of the Commonwealth, as laid down on said plan; the expense of dredging in Fort Point Channel, which will be required by the proposed changes therein, and of grading streets and building sewers over and through said flats; also, the probable expense of making compensation for the tidal water to be shut out by the filling of said flats; also, to ascertain and report on what terms and conditions the said walls, wharves, streets, sewers, or any parts thereof, can be built by any corporations or individuals, and on what terms and conditions the said flats, or any parts thereof, can be filled, and on what terms and conditions the said flats, or any parcels thereof, can be sold to any corporations or individuals, either for money or for filling other portions of said flats, and in what places and manner compensation for the tide-water shut out by filling said flats can best be made, and on what terms and conditions persons whose lands are to be affected by said compensation will give authority to make the same; also, on what terms and conditions the rights and interests of the riparian proprietors in South Boston, and others, can be harmonized with the proposed occupation and improvement of said flats; also, to report any other matters which said Commissioners consider as material in regard to the occupation of said flats; the said commissioners on all plans and proposals submitted by them, always regarding the protection and improvement of the harbor of Boston as of paramount importance, in any intended occupation of said flats."

In accordance with said Resolve we report as follows:—

Estimate of Building the Wharves and Filling the Flats.

SECTION I.

Wharves on Main Channel.

2,890 feet of exterior wall along Main Channel, .	\$418,880	99
14,000 feet of side walls and bulkhead walls for wharves,	1,149,381	04
2,187,500 square feet of filling of wharves,	684,687	50
Contingencies, 10 per cent.,	225,294	95
	—————	\$2,478,244 48

Pile-wharves on Reserved Channel.

424,700 square feet of pile-wharves, . . .	\$530,875 00	
Contingencies, 10 per cent., . . .	53,087 50	
	<hr/>	\$583,962 50

Filling of Flats.

3,648,850 square feet,	\$1,142,719 70	
Contingencies, 10 per cent.,	114,271 97	
	<hr/>	1,256,991 67

Probable Cost of dredging Fort Point Channel.

Excavation in Fort Point Channel,	\$188,133 90	
in docks or slips,	148,904 28	
Contingencies, 10 per cent.,	33,703 81	
	<hr/>	370,741 99

Probable Cost of making Compensation for Tide-water.

Excavation of 2,286,962 cubic yards of flats or marshes,	\$846,175 94	
Contingencies, 10 per cent.,	84,617 59	
	<hr/>	930,793 53
		<hr/>
		\$5,620,734 18
Building sewers and making streets,		427,842 98
		<hr/>
Total cost of Section I.,		\$6,048,577 16

SECTION II.

Wharves on Main Channel.

2,770 feet of exterior wall along Main Channel, . . .	\$374,778 33	
12,490 feet of sidewalls and bulkhead walls for wharves,	1,125,628 55	
2,118,850 square feet of filling of wharves, . . .	650,484 95	
Contingencies, 10 per cent.,	215,089 18	
	<hr/>	\$2,365,981 01

Pile-wharves on Reserved Channel.

511,500 square feet of pile-wharves,	\$639,375 00	
Contingencies, 10 per cent.,	63,937 50	
	<hr/>	703,312 50

Filling of Flats.

3,717,590 square feet,	\$1,163,607 85	
Contingencies, 10 per cent.,	116,360 78	
	<hr/>	1,279,968 63

Probable Cost of Excavation required in Docks.

Excavation in docks or slips,	\$176,553 27	
Contingencies, 10 per cent.,	17,655 32	
	<hr/>	194,208 59

Probable Cost of making Compensation for Tide-water.

2,161,644 cubic yards of excavation of flats or marshes,	\$799,808 28	
Contingencies, 10 per cent.,	79,980 82	
	<hr/>	\$879,789 10
		<hr/>
Building sewers and making streets,		\$5,423,259 83
		<hr/>
Total cost of Section II.,		\$5,921,964 02

SECTION III.

The exact limits of this section have not yet been defined, but the area and cost of construction may probably be set down as equal to that of Section I.

The necessity of providing an exterior wall at a cost of at least \$418,800, to confine the earth deposited has hitherto prevented any individuals or corporations from offering to purchase or fill any of these flats. If such a wall could be provided, it is the opinion of the Commission that certain portions of the flats can be disposed of on satisfactory terms, without danger of injury to the harbor, and thus furnish the means of further progress.

Under these circumstances the Commissioners were of opinion that these flats should first be offered to the city of Boston on liberal terms, and in order to bring the subject clearly before the city council, submitted a contract, which, if approved, they proposed to recommend to the legislature for their consideration. Sundry amendments were made and an order passed providing for the appointment of commissioners to manage the property in case it was granted to the city. A copy of the amended contract, the estimates accompanying it, and the action of the city government on the question are appended to this Report.

Should the legislature approve of the contract or any modification of the same, the Commissioners recommend that the offer should be made for a limited time, and in case it is not accepted, that they should be authorized, with the assent of the governor and council, to sell any portions of the flats to private individuals or corporations, payable either in money or the filling of other portions of the same; taking security that

the walls shall be erected so as to protect the harbor, and to carry out the plan adopted and authorized by the legislature, with the understanding that the State shall not be called upon to furnish any money.

WHARVES ON THE BOSTON SIDE OF FORT POINT CHANNEL.

At an early period letters were addressed by the Chairman, to the proprietors of Long, India, Central, Rowe's and Foster's Wharves, accompanied by plans and estimates showing the property that would be acquired, and the probable cost, and the amount that would be charged for tide-water displaced. These were laid before the several corporations. But they declined purchasing or extending their wharves according to the plan. Their refusal may render some alteration necessary in the lines and construction of the inclosures near the mouth of Fort Point Channel, and a change in the course of the channel from that proposed in the approved plan. The Commissioners would suggest the propriety of authorizing them, with the sanction of the advisory board and the approval of the governor and council, to make such changes as circumstances may require.

COMPENSATION FOR TIDE-WATER DISPLACED.

The Commissioners have made reports on sundry questions referred to them by the governor and council. And the governor and council, in conformity with the advice of the Commissioners have approved the filling of several wharves in the harbor of Boston, requiring in every case compensation for displaced tide-water, and the sum of eight thousand six hundred and sixteen dollars and eighteen cents, (\$8,616.18) has been deposited in the hands of the treasurer of the Commonwealth to the credit of the compensation fund of Boston Harbor.

Examinations have been made of the Mystic River and surveys of a portion of Charles River, in reference to compensation for tide-water displaced, and citizens have assured the Commissioners that they will, in consideration of the benefit to navigation, convey to the State, free of charge, the marshes that shall be required, and grant every facility in their power in aid of the undertaking.

RIPARIAN PROPRIETORS.

The only riparian proprietors interested in Section No. 1, are those between E Street and the Boston Wharf. These flats are owned by a number of individuals who have held, and paid taxes on them for many years with a vague idea that ultimately they might be of great value. There being some uncertainty as to the boundaries of their estates and the extent of flats to which they were severally entitled, negotiations were rendered difficult. After many private interviews, however, a meeting of the whole body of proprietors was called, and a committee appointed, who, after conference with a large majority of the owners, have submitted a plan by which they believe all claims can be adjusted, whenever the Commissioners are authorized to negotiate.

BOSTON LOWER HARBOR.

The Commissioners have made several visits to the lower harbor, and in order to obtain valuable advice and influence with the congressional committee, invited the advisory board. General Humphreys was unable to attend, but Admiral Davis, General Delafield and Mr. Henry Mitchell accompanied them. Re-surveys have been made of several headlands, and photographs taken of the bluffs, in order that the congressional committee might more clearly understand the absolute necessity of immediate action. They have, also, under the authority given them, forwarded in behalf of the Commonwealth a petition to Congress, of which a copy is annexed, for building sea-walls and removing obstructions in the harbor. This petition has been presented by the Hon. A. H. Rice, and referred to the committee on Commerce. The chairman and one or more of the Commissioners hold themselves in readiness on receiving notice to proceed to Washington to advocate the claims of the State.

OTHER HARBORS.

After due notice, the Board had a meeting at Lynn, on the 11th day of August last, with a view to establishing harbor lines, at which time the subject was fully discussed with the citizens of that place who were present. Since then, we have had a survey of the harbor made. As some questions of great importance, in regard to the improvement of the harbor were

suggested by the engineer, which if adopted would affect the harbor lines, we thought it best before settling the lines, to consult the advisory council. Their report is made and we expect it immediately. We have no doubt, that we shall be able to offer a bill for establishing harbor lines in Lynn harbor for the consideration of the legislature before its adjournment.

The Commissioners visited Gloucester, and on that occasion and subsequently approved the plans for the construction of several wharves authorized by the legislature in that place.

We have also approved the plans for the construction of certain wharves in Dighton authorized by the legislature.

JOSIAH QUINCY,
SAMUEL E. SEWALL,
WILLIAM MIXTER,
DARWIN E. WARE,
JOSEPH C. DELANO,

Harbor Commissioners.

APPENDIX.

PROPOSED ARTICLES OF AGREEMENT.

ARTICLE 1. The Commonwealth hereby grants to the City of Boston all the flats belonging to the Commonwealth, lying in Boston Harbor, within the exterior line recommended by the United States Commissioners on Boston Harbor, laid down on the plan annexed to the report of the Commissioners on Harbors and Flats, made to the legislature in the year 1866,—so far as the same have not been heretofore granted,—excepting from the grant the reserved channel as laid down on said plan, and the flats south of said channel and west of P Street extended; with power to fill the flats and build the wharves lying inside of said line according to said plan; with the right to lay vessels at the ends and sides of such wharves, and to receive wharfage and dockage therefor; and with power and authority within fifteen years to build and complete the Eastern Avenue, for the sum or price of one hundred thousand dollars, to be paid as hereinafter expressed. The said City of Boston hereby accepts said grant, and agrees that it will build, or cause to be built, all the outer walls of the wharves as contained in said plan, lying off the ends of Long, Central, India, Rowe's, Foster's, and Arch Wharves, and all the outer wall on the line laid down on said plan from the point of intersection of the Commissioners' line marked A, established by statute of 1853, chapter 385, and the easterly line of Fort Point Channel, as laid down on the said plan to the slate ledge, of stone masonry, under the direction of, and in a manner satisfactory to, the Harbor Commissioners, within seven years from the first day of July, in the year eighteen hundred and sixty-seven; and will also cause the new channel of the Fort Point Channel, as laid down on said plan, to be dredged out in the direction laid down in said plan, and in a manner satisfactory to said Harbor Commissioners, to the depth of twelve feet below low-water mark, within seven years from said date; and will also, within seven years, build that portion of Eastern Avenue, which extends from the Boston shore across Fort Point Channel, either as laid down on said plan, or with any of the changes of location heretofore authorized, which may be approved in writing by said Harbor Commissioners;

and will not commence the filling of any part of said flats until it shall be, in the opinion of said Harbor Commissioners, safe for the harbor of Boston; that no filling of the said flats or building of any wharves or walls thereon shall be made except in a manner satisfactory to said Harbor Commissioners, and in conformity with the said plan, or some modification thereof which shall not alter the outer line, and shall be satisfactory to said Commissioners, and approved by them in writing; and that the said City will also make compensation for all the tide-water to be excluded by the filling of said South Boston flats, now belonging to the said Commonwealth, from time to time as the filling thereof goes on, to the satisfaction of said Commissioners, in the manner hereinafter expressed. And the City of Boston may, in like manner, build all the outer wall, as laid down on said plan, as far as Castle Island, under the direction of the Harbor Commissioners and in a manner satisfactory to them, in sections, substantially as laid down on said plan; and, in such case, the said City of Boston shall make compensation for the tide-water shut out in the manner herein provided; and shall commence no filling beyond the slate ledge until in the judgment of the said Commissioners the outer wall is built far enough to protect the same. Provided, however, that, if the said Commissioners at any time after the expiration of fifteen years from the said first day of July, in the year 1867, shall, in writing, require the said City to proceed and build the outer wall on the second section or any part thereof, and the said City shall refuse so to do, or neglect for the space of six months to take any action in regard to said request, then the second and third sections shall revert to the Commonwealth.

ARTICLE 2. The Boston Wharf Company is hereby authorized and empowered to fill, with solid filling, so much of the flats over which, by the one hundred and fifty-fifth chapter of the Acts of the year eighteen hundred and fifty-five, said corporation was authorized to extend its wharf as lies inside the said line herein before described, and the easterly line of Fort Point Channel, as laid down on said plan, on the following terms and conditions, to wit: that the said Corporation shall not commence said filling until after the completion of the outer wall on the easterly line of Fort Point Channel, and shall complete said filling within three years thereafter, subject to the control of, and in a manner and to a height satisfactory to, the Harbor Commissioners; and, before commencing said filling, shall pay the City of Boston all the cost and interest of building the wall on Fort Point Channel, on the flats of said corporation, which may have been paid by said City, and shall make no claim upon the Commonwealth for damages on account of any change of harbor lines or otherwise, and no claim upon the City of Boston for damages on account of any acts done in pursuance of these articles of

agreement; and the City of Boston shall have power to lay out all necessary streets without paying compensation for the same, which streets the Boston Wharf Company shall build in a manner, of a width and to a grade as directed by the board of aldermen of said City. Said Boston Wharf Company shall make such compensation for displaced tide-water as may be adjudged by the Harbor Commissioners, in pursuance of the Act to establish a Board of Harbor Commissioners, passed in the year 1866; and the City of Boston shall have authority, without paying compensation therefor, to extend the reserved channel through the property of the Boston Wharf Company, or to alter the present channel, by widening, deepening, or otherwise changing the same, in such manner as the Harbor Commissioners may direct, provided that the Harbor Commissioners shall adjudge said extension or alteration to be either necessary or desirable.

ARTICLE 3. The City of Boston may, on such terms as it thinks expedient, borrow all sums of money which may be required to build the walls, wharves, streets and sewers; fill the flats, make compensation for tide-water excluded; pay for the services of the City Commissioners on Boston Harbor, hereinafter mentioned, or otherwise required for the improvement and occupation of the said flats, and the performance of all things to be done in pursuance of these articles, — the rate of interest, however, not to exceed the lawful rate. An account shall be kept by the City, in detail, of all moneys expended by the City in pursuance of these articles, and of all sums received from the sales of flats, lands, wharves, rents and dockage, and otherwise in every manner coming to the City from said flats and the improvements on the same. And, after all sums so expended by the City of Boston with lawful interest thereon, for and in regard to said first section, including the wharves aforesaid and the Eastern Avenue, are fully repaid by such sales, rents and otherwise as aforesaid, out of the net profits which remain, and are thereafter received by said City from the sources aforesaid, the said City of Boston shall pay the Commonwealth one hundred thousand dollars; and, after such payment, ten per cent. of all the net profits which remain, and are thereafter received by said City of Boston from the sources aforesaid, shall be paid by said City to the treasurer of the Commonwealth, and shall be by him kept and invested on securities bearing interest, as a harbor fund for the protection and improvement of the other harbors of the State, exclusive of Boston Harbor; and said fund and the income thereof may be at all times expended by the Harbor Commissioners, subject to the approval of the governor and council, for the protection and improvement of said harbors of the Commonwealth as they see fit, and may be drawn from the treasury by the warrant of the governor; and the remaining ninety per cent. of such

sums shall constitute a harbor fund for the City of Boston, to be safely invested by the said City in securities bearing interest, the income of which shall be applied from time to time by said City for the protection and improvement of said harbor, in such manner as shall be approved by the Harbor Commissioners in writing, and the same shall be done under their direction and inspection.

And the net profits arising from the second and third sections of said flats, as laid down on said plan, after the work upon them respectively is completed, shall be appropriated, ninety per cent. to the City of Boston for the benefit of Boston Harbor, and ten per cent. to the Commonwealth for the benefit of the other harbors of the State, as herein before provided in regard to the net profits arising from the first section, including the wharves aforesaid and the Eastern Avenue.

ARTICLE 4. The mayor shall nominate, and by and with the advice and consent of the city council appoint, three persons to be called Commissioners on Boston Harbor, to continue in office, from the time they are appointed, for the terms of three, four and five years respectively, from the first day of July next after their appointment; and, at the expiration of the term of office of any one of said Commissioners, shall in like manner nominate and appoint a Commissioner for the full term of five years: said Commissioners shall hold their offices until their successors are appointed, and shall be eligible to reappointment. Any one or more of the Commissioners may at any time be removed, after having had an opportunity of being heard in defence, by the concurrent vote of two-thirds of each branch of the city council; and, if any vacancy occur in the board from the death, resignation or removal of any member, a new Commissioner shall in like manner be nominated, and appointed for the remainder of the term. The city council shall fix the compensation of the Commissioners thus appointed, which shall not be reduced for any one during the term for which he is appointed.

ARTICLE 5. The City Commissioners on Boston Harbor shall have the charge of building the walls, and filling the flats, on all the said territory granted to said City of Boston, and of any and all other acts required or permitted to be done by the City of Boston under these articles in relation to said flats, and of making any purchases or agreements in pursuance thereof; and shall have full power to fill the flats so granted to the City, build wharves, and do all other acts necessary to make the property salable, and shall have power to prepare plans for laying out streets, and for the sewerage of the said territory, which shall be submitted to the board of aldermen, and shall build such streets and sewers thereon as the board of aldermen may direct. And said Commissioners may make all necessary contracts and agreements

in relation to the work to be done on said territory, at their discretion ; and shall have full power to sell and convey, and to lease from time to time any land, flats, wharves and other property of the City of Boston on said territory, and any parcels of the same ; and may employ such engineers, clerks and other assistants as the said Commissioners think necessary. Provided, that no contracts for building walls, filling flats, building wharves, grading streets, erecting buildings, making sewers, or any other contracts in relation to the flats so purchased by said City ; and no sales or leases of any land or buildings thereon made by said City Commissioners, — shall go into effect or be binding on said City, until the same are approved by the mayor and aldermen of said City ; and no payment shall be made by the treasurer of said City, under any contract of said City Commissioners, until the same has been duly audited. And the city council may from time to time pass such ordinances and regulations, not inconsistent with these articles and the laws of the Commonwealth, as it may deem expedient, to which said City Commissioners shall be subject. And provided further, that no part of said walls shall be built, no flats shall be filled, and no dredging done in any part of said harbor of Boston, by said City Commissioners on Boston Harbor, except in conformity with plans approved in writing by a majority of said Harbor Commissioners. Said Harbor Commissioners shall from time to time, in writing, award what sums of money are to be paid to make compensation for the volume of water shut out by any building of walls or filling of flats, as herein before mentioned, which, however, shall not in any case exceed thirty-seven cents for a cubic yard of tide-water, and shall give notice to the City Commissioners ; and the City shall from time to time pay all such sums as may be so awarded to the treasurer of the Commonwealth, who shall keep a separate account of the same, as the compensation fund of the City of Boston, and shall pay the same for making such compensation as may from time to time be required by the Harbor Commissioners, and for the payment of all damages thereby incurred, which payment shall be made on a warrant signed by the governor, the same having first been approved by the governor and council ; and the aggregate of the sums to be paid by said City for compensation shall not exceed in amount the sums actually paid by the Commonwealth for the work to be done as directed in the sixth article of this agreement, to compensate for the tide-water actually shut out by the occupation of the flats purchased by the City of Boston ; and any unexpended surplus shall be repaid to said City ; and, if the said City shall at any time neglect to pay any sum so awarded by said Harbor Commissioners for compensation, the said Harbor Commissioners may recover the same in an

action of contract, brought in the name of the Commonwealth, against the said City of Boston.

The said City Commissioners shall annually, on or before the fifteenth day of January, make a report in writing to the legislature, and also to the city council of Boston.

ARTICLE 6. It shall be the duty of the Harbor Commissioners to make compensation for the tide-water hereafter to be displaced by the filling of the South Boston flats and any other flats, and the building of bridges and wharves, and other encroachments on Boston Harbor, by deepening or causing to be deepened the outlet of the lower Mystic Pond and the Mystic River from said pond to Medford Bridge, and by excavating, or causing to be excavated, flats in the Mystic River, Malden River, Chelsea Creek and Charles River, and the adjoining marshes, and otherwise; provided said Commissioners shall never pay any more money for such purposes than the amount of the compensation fund of the harbor of Boston, provided for by the fourth section of the Act of the year 1866 to establish a Board of Harbor Commissioners, and the amount received under the fifth article of this agreement; and every contract in regard to said pond, rivers, and creek, and elsewhere for compensation, made by said Commissioners, involving the expenditure of one thousand dollars or more, shall, before going into effect, be submitted to, and approved by, the governor and council.

ARTICLE 7. The Harbor Commissioners before doing, or authorizing to be done, any of the work authorized by the preceding article, on any flats, marshes or other places, not owned by the Commonwealth, or in any place which may injure the property of any person or corporation owning land near such intended work, shall either get the written consent of all parties interested, on such terms as the Commissioners approve, or, otherwise, shall publish in some newspaper printed in Boston a statement of the work intended to be done in any place or places, and that a hearing will be given to all parties interested at some convenient time and place, to be specified in the notice; which notice shall be published three weeks successively in some newspaper printed in Boston, the last publication to be three days, at least, before the time of hearing. And the Commissioners shall, at the time and place appointed, give a full hearing to all parties; and shall thereupon award and determine what land they will take for the purpose of compensation, and what work they propose to have done upon it; and shall thereupon award damages to any persons whose property the Commissioners think will be injured by the work proposed, to the amount of injury which the Commissioners think such persons respectively will sustain, and refuse damages to such as the said Commissioners think will sustain no damage; and the said Commissioners shall keep a record of their proceedings,

which shall contain a full description of all land taken, and the nature and extent of the work to be done on it, with the names and descriptions of the persons to whom damages have been allowed or refused. The treasurer of the Commonwealth shall pay the amount awarded to the persons to be damaged by the work on said land, on receiving a duly certified copy of the award. The Harbor Commissioners shall cause a description of all land taken in manner aforesaid, and of the work to be done on it, certified by the clerk of the board, to be recorded in the registry of deeds in the registration district where the land lies, within thirty days after the land has been taken.

Any person not satisfied with the award of the Commissioners, may, by petition presented to the superior court, sitting in the county of Suffolk, or in the county in which his land lies, at his option, at any time within three months from the time of making the award, have a jury trial, and a re-hearing on the question of damages, and a re-assessment of the damages, if any.

In any case where the Harbor Commissioners think that any proposed work of compensation will benefit the property of any person, they shall have power to enter into a contract with such person, and engage to have the work done, on his paying or securing the payment of such sum as may be agreed on between him and said Commissioners.

City of Boston.

IN COMMON COUNCIL, Dec. 27, 1866.

Ordered, That in the month of January, in the year 1867, or within sixty days thereafter, the mayor shall nominate, and, by and with the advice and consent of the city council, appoint three persons to be called Commissioners on Boston Harbor, to hold their offices for the terms of one, two and three years respectively from the first day of said January, and until their successors are appointed; and, afterwards, in the month of January in each year, or within sixty days thereafter, shall in like manner nominate and appoint a Commissioner, to hold his office for the term of three years from the first day of January in the year of his appointment, and until his successor is appointed; and said Commissioner shall be eligible to re-appointment. Any one or more of the Commissioners may at any time be removed, after having had an opportunity of being heard in defence, by the concurrent vote of two-thirds of each branch of the city council; and, if any vacancy occur in the board from the death, resignation or removal of any member, a new Commis-

sioner shall in like manner be nominated and appointed for the remainder of the term. The city council shall fix the compensation of the Commissioners thus appointed.

Ordered, That the said Commissioners shall investigate the whole subject of filling the flats, and otherwise improving Boston Harbor, substantially in accordance with the plan proposed by the Harbor Commissioners of the Commonwealth in their communication to the Committee on the Harbor, dated the ninth day of October, A. D. 1866, including the expense of doing all the work proposed by said plan; the salable value of the lands and wharves which would belong to the City at the completion of the enterprise; the extent, if any, to which private rights would be injuriously affected by the execution of said plan; and all other matters and things, of every description, pertaining to the interests and duties of the City in the premises: and to make report annually of their doings to the city council.

Passed. Sent up for concurrence.

JOSEPH STORY, *Pres't.*

IN BOARD OF ALDERMEN, Dec. 31, 1866.

Concurred.

G. W. MESSINGER, *Chair'n.*

Approved Dec. 31, 1866.

F. W. LINCOLN, JR., *Mayor.*

A true copy.

Attest:

S. F. McCLEARY, *City Clerk.*

IN BOARD OF HARBOR COMMISSIONERS, Dec. 5, 1866.

Voted, That the Chairman be requested to present the following question to the Advisory Council for their consideration:—

Whether it appears to the Advisory Council that the carrying out of the plan for the occupation of the flats owned by the Commonwealth in Boston Harbor, approved by the legislature, so far as is represented by the red lines on the plan on the Boston side, and the first section on the South Boston side, is so important to the improvement of the harbor of Boston that it ought to be carried out by the City of Boston, even if the sales of property created were not likely to remunerate the expenses of the work.

REPLY OF THE ADVISORY COUNCIL.

In reply to the question presented to the Advisory Council by the Board of Harbor Commissioners of the fifth inst., we have to state, first, that a reasonable interpretation is to be understood, as otherwise, the question being expressed in such general terms, an answer might be construed to include an extreme case.

The object, however indirect and distant, of any harbor improvement is the realization of pecuniary advantages, either national or local, or both combined, but in the many recommendations the United States Commissioners have made relative to the proper mode of maintaining or improving Boston Harbor, they have neither approved nor advocated any scheme for the sake of its intrinsic merits as a profitable enterprise to any local or individual interest.

On the contrary, they have earnestly and repeatedly, and at last successfully, urged the appointment of a local Commission, which, occupying a different relation from themselves, would consider how far these recommendations can be carried out; how far the present and prospective wants and wealth of the City in its connection with national commerce and inland traffic will warrant the necessary expenditure for maintaining and improving the harbor.

In the case of South Boston Flats, now more particularly brought to our attention by the question of your Harbor Commissioners, the United States Commissioners were very far from suggesting a profitable investment of public funds, to benefit any special interests. In the report of the United States Commissioners of 1861 (4th,) it was first suggested to separate these flats from the harbor by a quay wall, and dredge out the interior basin to a navigable depth, — which would involve a direct outlay without remuneration.*

* “ *It is our opinion that a proper structure on the flats would prevent the premature dispersion of the South Bay stream, and perhaps extend its power to the margin of the Main Channel. The structure referred to, which might be simply a quay wall, if extended round the northern portion of the flats along the line or limit of scour (see the determined portion of this line upon Diagram A.,) would serve to prevent in part the dispersion of the currents in the Main Channel, which now occurs in this neighborhood. The basin or dock within this wall should be deepened in order that a portion of the tidal power, now superficial, might then re-enforce the activity in the lowest water stratum of the channel.* ”

It cannot be questioned that the volume of tide-water which flows over flats and shallow basins, is useful at distant points, although its tendency to increase the scouring power, is not felt in the immediate vicinity. ” [4th Report, page 10.]

“ We did not then [in 4th Report] speak of occupation. We did not even know that the space we proposed to cut off from the harbor had any pecuniary value. We admitted that the tide which covers these flats had no value as re-enforcements to the main stream in the adjacent channel; and that it could only be useful at a distance; but the idea of removing it, or transferring it above that part of the Main Channel requiring re-enforce-

In their report of 1863 (the 5th,) the Commission concluded from further surveys and discussions, that a transfer of tide-water from South Boston flats to basins above the city would be an advantage to the harbor; and in their sixth, seventh and ninth reports, they define the character and limits of occupation and compensation; but always with strict reference to an improvement of the physical conditions of the harbor for commerce.*

As only two of the present Advisory Council have been associated with the work from an early period of its labors, we have preferred to fortify our position, and answer to this question, by references to the reports written by those actually engaged in the investigation, especially as their testimony is clear, and, as we think, wisely considered.

The occupation of South Boston flats, at first suggested in early reports, gained importance in the minds of the U. S. Commissioners as their hydrographic and physical surveys advanced; and finally the Commission has recommended the occupation of the flats for commercial and other industrial purposes, provided a quay wall be first constructed along its channel side, the main ship channel dredged abreast of this quay, and a reservoir created above the City as a receptacle for as much tide-water, or an equivalent, to keep open the ship channel above and below the City, as well as along its wharves.

We may reiterate that our views and purposes have invariably been to attain the general benefit of the community in all that affects its prosperity, growing out of its local advantages for commerce and trade, and in looking forward to the increase of maritime interests, as well as the existing conditions connected with it.

In further answer to your question we must remark, that, in view of the present connection of the City of Boston by rail with the Northern and Western lakes, thence from the shores of Lake Michigan by numer-

ments, had never been discussed in our councils. On the contrary, we speak, in the quoted paragraph, of deepening the enclosed basin so as to make its tide execute its work upon a lower plane, and really do service in the Main Channel by this means. Subsequent examinations in the upper harbor confirmed us in the view that a quay wall about the flats would be a benefit, especially to the Main Channel, and that its early construction would be highly desirable. We also decided that the interior space might be reclaimed, provided that *compensation in kind for displaced tide-water should be made*. In this transfer of tide-water, we believed we saw an opportunity for making it far more useful, by *acting from a distance*, than by any local change of depth, &c." [10th Report, page 88.]

* "Finally, our general conclusions from the foregoing arguments and illustrations are, that a transfer of a portion of the tidal prism from the South Boston flats to the Mystic and Charles Rivers would be beneficial to the harbor. Degradation of the tide wave should be prevented by giving uniformity to its path; and its inland journey should be hastened and extended by deepening the rivers." [5th Report, page 34.]

ous railroads to the Mississippi; and the immense and rapid increase of population to interchange their industrial labors,—we consider that no reasonable sum the present population of this City can afford, can exceed the direct and future benefits to arise from improving the harbor, and securing its increased capacity, which cannot be overestimated in producing a lasting benefit to its inhabitants, independent of any reasonable sum it may cost to effect the object, over and above the amount of sales of property to be reclaimed from the submerged flats.

C. H. DAVIS,

Rear Admiral and Chairman.

RICHARD DELAFIELD,

Brevet Maj. Gen. Corps of Engineers, U. S. A.

HENRY MITCHELL,

Asst. U. S. Coast Survey,

Advisory Council to Harbor Commission.

To certain questions proposed to the United States Commissioners by the Board of Harbor Commissioners, answers were made as follows :—

First Question. Is the extension of Central, India, Rowe's and Foster's Wharves essential to the plan proposed for the improvement of Boston Harbor; that is, could the flats on the South Boston shore be filled without injury to the harbor, if those wharves were not extended?

Answer. This extension becomes a necessity with the plan of the State Commission, but was not deemed absolutely so with our plan, (Fifth and Sixth Reports.)

Second Question. Would it be possible, without injury to the harbor, to close the present entrance to Fort Point Channel, and open another entering the main channel at some lower point?

Answer. We think not, in accordance with the plan of the State Commission.

Third Question. Whether a wall on the exterior line, recommended by the Commissioners, will do all they propose for the preservation of the harbor, without the occupation of the flats?

Answer. Not while we have in prospect a compensation for the flats in an enlargement of the reservoirs above the city.

Fourth Question. Would a rip-rap wall on that line prevent the occupation of those flats by wharves hereafter?

Answer. Yes; unless faced on the channel side with stones laid by hand, and precautions taken to provide proper openings faced with masonry.

Fifth Question. Would the establishment of a reservoir at the head of Mystic River be beneficial, if the wall enclosing the South Boston flats should not be constructed?

Answer. Yes; decidedly.

Signed,

C. H. DAVIS,

Rear Admiral, and Chairman.

RICHARD DELAFIELD,

Brevet Maj. Gen. Corps of Engineers, U. S. A.

HENRY MITCHELL,

Assistant U. S. Coast Survey.

COPY OF THE PETITION TO CONGRESS.

To the Honorable Senate and House of Representatives of the United States in Congress assembled, the petition of the undersigned, Harbor Commissioners of the Commonwealth of Massachusetts, acting under the authority, and on behalf of the said Commonwealth, respectfully represents—

That, during a long period the United States has been expending money in building sea-walls on the islands in the outer harbor of Boston. These works have been very useful; but the thorough surveys which have in recent years been made under the direction of the United States Commissioners on Boston Harbor, in connection with re-surveys we have had made the present year, have shown in a more striking manner than before, not only the destructive agencies at work in this locality, but the necessity of prompt and energetic action to arrest the progress of destruction, and to remedy, as far as possible, the evils it has already occasioned.

Hoping for the immediate action of Congress, on this subject, we ask your attention to a brief enumeration of the places on which work ought to be done the coming season, and of the kind of work required.

We first ask your attention to the localities in which efforts should be made to arrest encroachments by the sea, and to prevent the further escape of sands, earths, &c., into the harbor or its immediate approaches.

1. POINT ALLERTON.—This prominent headland, at the entrance to Nantasket Roads and Boston Harbor, terminates on the channel side, in a bluff, whose height above the plane of ordinary high-water, is forty-eight feet. From the foot of this bluff a dangerous spit projects, whose outer extremity is marked by a stone beacon. During the last six years the crest of this bluff has retreated thirty feet, in the average, along a distance of seven hundred feet. A sea-wall is required. The facility of the approach from seaward, the safety of the entrance, and the protection of the roadstead are greatly dependent upon the fate of this headland.

2. LONG ISLAND—NORTH HEAD.—This bluff, whose nearly uniform height is seventy feet, faces the main channel. Its crest has retreated during the last six years, thirteen feet (average,) for a distance of 1,600 feet. A sea-wall is required.

3. GALLOPS ISLAND.—The north-east bluff of this island, facing the *main ship channel, whose low-water width is here less than six hundred feet*, has a maximum height of sixty feet, and an average height of twenty-nine feet. Its crest has retreated, during the last six years, twelve feet on the average, along a distance of 1,400 feet.

4. LONG ISLAND—SOUTH HEAD.—This bluff, whose maximum height is fifty-three feet, average thirty-four feet, faces the back or western way. Its crest, for a distance of 1,100 feet, has retreated eighteen feet (average,) or thirty feet (maximum,) during the past six years.

5. GREAT BREWSTER.—The bluff at the north-easterly point, and along the west side is seventy feet in height. Its crest, for a distance of eight hundred and fifty feet, has retreated in the average, twenty feet during the last six years. An extension of the wall for this entire distance, is required; also a proper grading and planting of the bluff, which this wall is designed to protect.

The eastwardly bluff, at the foot of which a wall has been already built, requires grading and planting. At present great masses of earth escape over the summit of the wall during storms.

The "planting" referred to above, might be done either with upland or beach grasses, together with pines, bayberry and other hardy shrubs.

6. MOON ISLAND.—The bluff bordering upon the back or western way, has a maximum height of eighty-two feet—average forty feet. The crest has retreated, during the past six years, fifty feet along a distance of eight hundred feet. A sea-wall is required.

7. NANTASKET BLUFF.—This cliff faces Nantasket Roads. Its general height is fifty-seven feet; and during the past six years, its crest has retreated twenty-two feet (average,) along a distance of eight hundred feet. A sea-wall is required.

8. WINTHROP HEAD.—The bluff faces Broad Sound with a maximum height of ninety-one feet—average forty-two feet. The crest of this bluff has retreated, during the past six years, fifteen feet in the average along a distance of 1,000 feet.

The bluffs above referred to, are composed of sands, clays, shingle, and occasional boulders. The material usually falls in large masses, under the action of the waves during storms, and sometimes, more gradually, under the action of frosts and rains. If secured from the undermining of the sea, and properly graded, these bluffs may be rendered perfectly secure by planting with pines, shrubs, and grasses.

During the past six years 271,200 cubic yards of material from these bluffs have found their way into valuable portions of the harbor and its immediate approaches.

There are several serious obstructions to navigation in Boston Harbor to which we next call your attention.

1. In the most critical portion of the Main Ship Channel (of Boston Harbor,) off the Great Brewster Spit, where the width between the 12-foot curves is but 760 feet, there lies two dangerous obstructions. One of these, bearing the name of Tower Rock, has a low-water depth of about 17 feet; the other, Corwin Rock (see U. S. Coast Survey Report of 1860, Appendix No. 10,) has a mean low-water depth of 17 feet. Between these two objects, where lies the track of deep draught vessels, the distance is only 255 feet. Both of these objects should be removed by blasting or otherwise.

2. The Great Brewster Spit itself, having extended 180 feet during the last fifteen years, has become a serious impediment to navigation, and should be, at least for the distance named, removed by dredging, or otherwise. The material is gravel and shingle.

3. In another portion of the Main Ship Channel, an extension of Lovell's Island has taken place, reducing the water-way, between the 12-foot curves to 384 feet. This is the narrowest part of the Channel, and the site of frequent accidents in navigation. This extension should be removed by dredging or otherwise. The material is gravel.

4. The bar obstructing the Main Channel of the Upper Harbor, about a mile and a half below the city, has a general depth of about 15 feet at mean low-water, along the pathway of vessels; there is, however, a narrow lead through it (110 feet minimum,) where 19 feet is found. This bar should be removed by dredging, or otherwise. The material is hard clay.

These obstructions prevent the safe entrance to the harbor to national vessels as well as commercial vessels of the larger class, except at high-water.

Your petitioners are aware that in a bill reported at the present session, appropriations for sea-walls are proposed at several places in the harbor besides those we have indicated as needing them. But the points to which we have called attention are equally exposed, and equally require immediate action.

We regard the prompt commencement and steady prosecution simultaneously, of all the works necessary for the protection and improvement of Boston Harbor, under the direction of one experienced and skilful officer, as of the highest importance. Such a course would be far more beneficial to the harbor, than if the beginning of some works should be delayed to await the completion of others, and would be the exercise of a judicious economy, on the part of the United States. For every year's delay increases the magnitude of the works required for protection, and still more of those needed for remedying evils incurred during the delay.

Your petitioners, therefore, pray your honorable bodies to make a specific appropriation for work on each headland before mentioned; another for the removal of the Tower and Corwin Rocks; another for the removal of a portion of the Great Brewster Spit; another for removing the extension of Lovell's Island from the Main Ship Channel; and another for removing the bar in the Main Ship Channel in the inner harbor.

If the total amount which your petitioners ask for seem large, it ought to be recollected that the preservation and improvement of one of the finest harbors in the country, and which has yielded, and is still yielding, an immense revenue to the national treasury, and which contains a great navy yard, is an object of the first national importance.

JOSIAH QUINCY,
SAMUEL E. SEWALL,
WILLIAM MIXTER,
DARWIN E. WARE,
JOSEPH C. DELANO,

Board of Harbor Commissioners.

Commonwealth of Massachusetts.

SECOND ANNUAL REPORT

OF THE

Board of Harbor Commissioners.

JANUARY, 1868.

BOSTON:
WRIGHT & POTTER, STATE PRINTERS,
No. 4 SPRING LANE.
1868.



CONTENTS.

	Page.
Lower Harbor,	1
South Boston Flats,	7
Compensation,	12
Changes in the Bed of Boston Harbor,	15
Charles River,	18
Bridges,	19
Lynn Harbor,	20
Salem Harbor,	20
Cape Cod Harbor,	21
Works Approved,	21
Legal Proceedings authorized by the Board,	21
Compensation Fund,	21

CONTENTS OF APPENDIX.

Report of General Foster,	23
Report of General Benham,	28
Report of U. S. Advisory Council,	31

REPORT.

*To the Honorable the Senate and the House of Representatives
of the Commonwealth of Massachusetts.*

The Board of Harbor Commissioners, established by chapter 149 of the Acts of the year 1866, respectfully submit their Second Annual Report.

BOSTON LOWER HARBOR.

In our Report of last year, we stated that under the authority of the Commonwealth we had forwarded a petition to Congress, praying that an appropriation might be made for removing obstructions from the Main Ship Channel, and building sea-walls to protect the headlands of Boston Harbor.

This petition was referred to the Committee of Commerce, and late in the session reached Major-General Humphreys, Chief Engineer of the United States, through the Secretary of War. At this stage, the Chairman and two members of the Board, accompanied by the Harbor Committee of the city government, proceeded to Washington with surveys and photographs of the localities, and with plans and estimates of the work required, and laid all the papers before General Humphreys, who expressed his satisfaction with the fullness of the data that left nothing further to be desired.

He reported to the Secretary an estimate of about \$1,030,000 to cover the entire work, and suggested an appropriation of \$375,000 for the ensuing year. The papers were not returned to the Committee by the Secretary with his recommendations until after the general Bill had been reported; but through the exertions of Hon. T. D. Eliot, the estimate for Boston was added as an amendment to the Bill, and passed the House. In the Senate some opposition appeared, but the clear statement of the case by Hon. Charles Sumner, removed all objections.

Our success was in great measure due to the able manner in which our Engineer, Mr. Boschke, had prepared all the papers, and to the fact that we were able to act as an organized board, charged by the legislature with special duties in relation to the harbors of the Commonwealth, and to perform such duties, as the representatives of the Commonwealth.

The work provided for has been in progress during the past season, under Major-Generals H. W. Benham and J. G. Foster. To the latter was assigned \$300,000 for prosecuting the new works, and to the former \$75,000 for completing works already in progress or in process of repair. From both of these engineers we have reports which we append. The work under General Foster has already made encouraging progress, and met with that success which was expected under his able leadership. The field of his work has thus far been the Main Ship Channel, or Narrows. In the most critical part of this channel there lay two dangerous obstacles known as "Tower" and "Corwin" Rocks, with a passage between them of scarcely 200 feet. Tower Rock was first attacked by General Foster, and reduced in eight weeks; *there are now twenty-three feet of water at low tide over its ruins.* Corwin Rock, a much larger obstacle, was next assailed, and before the working season closed, two hundred tons had been blasted out, and most of it landed on the beach. Four months' work next spring will remove what remains.

In another contracted portion of the Main Ship Channel, the removal of a part of Lovell's Island is in fair progress. This work is designed, when finished, to increase the width of the channel-way from 360 to 685 feet. This is an excavation in sand and shingle, and General Foster reports that "it has been carried forward by the contractor with great energy in spite of the many obstacles, and with such success that, up to the time of suspending work for the winter on the 30th of November, 53,453 cubic yards had been excavated and removed." We would call particular attention to that part of General Foster's report relating to the difficulty of obtaining the necessary title to the land required for the sea-wall to be built around Point Allerton, the importance of obtaining this title at an early day to enable the work on the wall to begin in the spring, and hope the legislature will give a favorable con-

sideration to his suggestion, that the Commonwealth give authority to take under the right of eminent domain the land required, and transfer the same to the United States. It is of great importance to the Commonwealth that the work to be done on Point Allerton (which will be done by the United States at an expense of \$100,000,) should be begun as soon as possible.

Of the \$75,000 placed in the hands of General Benham, only \$25,000 has yet been required, there having been funds left over from last season. Four hundred and thirty feet of wall have been laid at the north head of the Great Brewster Island, completing the protection of this head as far as stone work is concerned. General Benham's report enumerates other constructions and repairs executed with funds from former appropriations.

THE SOUTH BOSTON FLATS.

In the year 1866, the year in which this Board was established, the legislature adopted a plan for the improvement of the South Boston Flats, whose main features were these: an extension of the wharves on the westerly side of Fort Point Channel, for the purpose of giving a proper direction to the currents; the construction of a sea-wall on the easterly side of Fort Point Channel, which should inclose the flats as far as Slate Ledge and serve for the ends of wharves which should be built upon the flats thus inclosed, after having been filled; and extensive excavations in the tidal reservoirs of Boston Harbor, to compensate for the tide-water displaced by this filling. The Board were at the same time charged with the duty, which they performed, of submitting to the legislature of 1867, a scheme for carrying into execution the improvement of the South Boston Flats upon the foregoing basis.

The legislature of 1867, by an Act to be found in chapter 354 of the Acts of that year, authorized the Board to contract for the building of a sea-wall on the South Boston Flats upon the following conditions: The wall must be "a continuous sea-wall," built on a line "within and parallel with the exterior line to the point known as Slate Ledge, as laid down upon the plan" of the year 1866, already referred to; provision is made that an engineer shall be appointed by the governor, whose

duty it shall be to prepare plans and specifications for proposals and contracts for the building of such sea-wall, to determine the requisite amount of dredging to be done in front of the wall, and the amount of filling in rear of the wall necessary for a proper support; he is to consult with the Harbor Commissioners and locate the line of the wall and decide upon the amount of dredging and width of filling for a support to the wall, "with due regard for economy and strength, as well as the proper direction of the currents of Boston Harbor;" the Board were to advertise for proposals and execute the contract for the work, but the plans and specifications and the line of the location of the wall by the engineer were subject to the approval of the governor and council; nor were the Board to execute a contract until it had been accepted and approved by the executive. Two hundred thousand dollars were appropriated for the work.

The Board were also authorized to modify the line of the easterly side of Fort Point Channel, with a view to enlarging the area of improved land on that side, and of reducing the extension of wharves on the westerly side of this channel, provided for on the plan. This line has, with the approval of the U. S. Advisory Council, been changed accordingly, and now is as follows:—

Beginning at a point of intersection of the line marked A on the Commissioners' line established by chapter 385 of the Acts of the year 1853, with the easterly line of Fort Point Channel; thence running north-easterly 1,300 feet to a point easterly of the south-east corner of Arch Wharf, and 600 feet therefrom; thence northerly and easterly on an arc of a circle of 910 feet radius for a distance of 1,255 feet; thence easterly and southerly, on an arc of a circle of 2,370 feet radius, for a distance of 800 feet to a point in the exterior line recommended by the United States Commissioners on Boston Harbor.

The following line becomes necessary as the westerly line, in consequence of the above change, and was adopted by the Board, with the approval of the U. S. Advisory Council:—

Beginning at the south-east corner of Arch Wharf and running north-easterly along the face of said wharf to its north-east corner; thence on an arc of a circle of 1,210 feet radius for a distance of 1,190 feet; thence on an arc of a circle of 870 feet

radius for a distance of 470 feet, to a point in the exterior line recommended by the United States Commissioners on Boston Harbor. The plan of 1866 thus modified is appended.

Upon very careful investigation of the subject, for the purpose of giving an interpretation to the Act of 1867 consistent with its terms, with the plan of 1866, which was not modified by the legislature of 1867, except in the one particular of an authorized change of the line of the easterly side of Fort Point Channel just referred to, and of giving an interpretation consistent with the security of Boston Harbor, the Board, in the discharge of their duty to advise the State Engineer as to the proper line for the location of the sea-wall and the kind of wall to be built, recommended him to place it on a line one thousand feet "within and parallel to the exterior line, to the point known as Slate Ledge, as laid down upon the plan" of 1866, and to construct a continuous wall which would be available for a retaining wall while the work of filling the flats was going on, and would cost about the amount of the appropriation. We recommended this line for the following reasons:—

1. The statute authorized the construction of "a continuous sea-wall." The plan of 1866, and one main purpose of the improvement, viz., to make a deep water frontage sufficient to accommodate with wharfage the largest ships, required that any wall built on or near the exterior line laid down on that plan should be divided by spaces for docks which should separate wharves of which this wall should form the ends; consequently no "continuous sea-wall," we concluded, could be placed on or near a line which was to be the line of the ends of wharves and the openings of slips and docks.

2. The cost of a wall properly constructed on or near "the exterior line" on the plan of 1866 would many times exceed the amount appropriated for its construction.

3. The Act of 1867 provided for no extension of the wharves on the westerly side of Fort Point Channel, whereas, in the plan of 1866 and in the opinion of the United States Commissioners who investigated the matter, such an extension is inseparable from the construction of a sea-wall on the easterly side of Fort Point Channel, upon the exterior line of the plan of 1866 to Slate Ledge, and is indispensable for that "proper direction of currents in Boston Harbor," for which the Act

itself provides that "due regard" shall be had in locating the wall.

We advised the adoption of a line one thousand feet "within and parallel with the exterior line of the plan" of 1866, because a proper wall could be built on that line within the appropriation, which would be serviceable as a retaining wall for a partial but useful reclamation of the South Boston Flats and as the heads of docks and slips, whenever, by the building of the sea-wall on or near the exterior line on the plan of 1866, wharves should be built out to that line and the plan of this improvement executed in its entirety. Furthermore, on consultation with the U. S. Advisory Council, we were satisfied that "with due regard to the direction of the currents of Boston Harbor," and without injury to the harbor, such a wall could be built on that line without any extension of the wharves on the western side of Fort Point Channel, until such time as the wall should be built on the other side of the channel upon the exterior line of the plan.

The State Engineer agreed with us in the principles upon which we adopted the line we have stated, but fixed the line at eight hundred, instead of a thousand feet from the exterior line of the plan, as we had recommended, because he thought eight hundred feet would be a sufficient length for the docks to which such a wall would some day form the heads. His estimates exceeded but a little the appropriation. Subsequent proposals received by the Board, show that this wall could have been built for a sum within the appropriation of the legislature.

After a full hearing, however, in the course of which members of the legislature of the year 1867 who framed the Act authorizing the construction of the wall, testified that the line intended by them for the "continuous sea-wall" was near the exterior line of the plan of 1866, the executive decided that the line of the wall should be parallel and within this exterior line of the plan and fifty feet distant therefrom, and that the plans and specifications of the engineer should be modified accordingly. The engineer submitted the required plans and specifications for a suitable wall on the line approved, and on these we duly advertised for proposals. Proposals have been received by the Board in response to such advertisement and

laid before the executive, but the necessary executive action thereon, without which the Board cannot contract for the construction of the wall, has not been taken.

The adoption of this line as the line of the wall on the deep water front of the land to be improved will render necessary some additional legislation to enable the Board to build a wall that shall be as useful as possible for commercial purposes.

1st. Authority should be given to the Board to leave openings in the wall wherever they may be needed for docks and slips, and the provision in the Act of 1867 authorizing the construction of a continuous sea-wall be modified accordingly.

2d. During the progress of the work, provision should be made for the extension of the wharves on the western side of Fort Point Channel. This extension can probably be better secured by the voluntary action of their owners during the progress of the work than at the present time.

3d. The legislature will be obliged to make a much larger appropriation for the work, or what will, perhaps, prove the more acceptable proposition, authorize the Board, subject to the same conditions of approval by the executive as now, to contract to pay for the wall in part of the improved land to be inclosed by it.

In order, however, to make such a contract, or any contract providing for payment in the improved land, the Board should be authorized, upon consultation with the various interests that are looking forward to the occupation of the improved territory, if advantageously laid out, to prepare for the action of the legislature thereon, a plan for the occupation of this territory, with especial reference to the accommodation of railroads and ships, and for the reservation of lands to the contractors and the Commonwealth in such a manner as shall not interfere with the great interests of commerce, which it is the desire of the Commonwealth by this enterprise to promote.

There is no such plan in existence. The plan of 1866, approved by the legislature, was a plan which showed merely the extent and outlines of the filling, the walls and channels. It was in no respect a plan according to which the new territory was to be put to its uses. The advantages of this improvement to the commerce of Boston, turn on the economy with which the freight of railroads can be placed on board of ships

in Boston Harbor, and a plan for the reservation of land for contractors, whether for the wall or the filling, which shall meet the requirements of commerce in this particular, is of prime importance. Then, too, the most economical mode of contracting for work is to include the whole in the contract, by anticipating in a well digested plan the requirements of the work to be done, and so reducing the item of extra work to be paid for at extra prices, to the lowest terms.

Moreover, as there is no one legally authorized to invite proposals for the filling of the flats and the construction of the wall in one contract, taking payment for the same in land, and no proposals made except to a body authorized by law to receive them would bring out a satisfactory competition, we would recommend that the legislature authorize us to advertise for proposals, under one contract, both for the filling of the flats, on a plan to be submitted to the legislature and approved by them, and for the construction of the wall upon the line already adopted by the executive, and to authorize us to make such a contract, if it shall be approved by the legislature. We believe that if the requisite authority is given to us in the early part of this session, we can mature an acceptable plan for the occupation of these flats, and obtain a contract both for the filling of the flats and the building of the wall on the basis we have indicated, which the legislature will be able to act upon and be disposed to approve, before its adjournment. The main work of the improvement can then at once be entered upon. As soon as this is done it will be an easy matter to negotiate advantageously with the riparian owners of flats along the shore of South Boston; to obtain from the owners the necessary extension of their wharves on the Boston side of Fort Point Channel; to exercise the authority which the Board has, under chapter 81 of the Resolves of the year 1866, to contract with the city of Boston for the construction of Eastern Avenue, and adjust all the other subordinate questions that are incident to the execution of the main plan.

The additional legislation we have suggested being supplied, we earnestly recommend that the work of building the wall on the line on which it has been located, and of filling up the flats, be entered upon as soon as possible; and with the view of obtaining during the present session, the sanction of the legislature

to the final contracts and arrangements to be made before the work is begun, we respectfully urge that the necessary legislation be supplied at as early a day as possible.

COMPENSATION.

By chapter 93 of the Resolves of the year 1867, a committee of the legislature of that year was appointed with certain powers in relation to the South Boston Flats, and the Board of Harbor Commissioners were charged with the duty of advising this committee upon the subject of compensation for the tide-water that will be displaced when these flats are filled.

The legislature of 1866, in adopting the plan for the improvement of the South Boston Flats, and in charging the Board with the duty of preparing a scheme for carrying this plan into execution, assumed that "compensation in kind" was the only secure basis on which the proposed improvement could be accomplished. We have familiarized ourselves with the doctrine of compensation in kind adopted by the Commonwealth in the establishment of this Board, and recommended by the United States Commission, as a remedy for the evils resulting from encroachments upon the tide-water of Boston Harbor, and have diligently studied the means for its strict application in the case of the proposed occupation of the South Boston Flats. Predisposed to accept this doctrine, because of the high authority from which it emanates, it remained only for us to inquire into the practicability of its application from a financial point of view. This inquiry has led to serious doubts as to the practicability of replacing the tide-water of South Boston Flats by new reservoirs above the city. Prompted by such doubts, we instituted an investigation for the purpose of working out another solution of the problem, and have obtained a solution which is perfectly satisfactory—a solution which, without being inconsistent with views heretofore entertained, realizes the objects of the United States Commission in a plan of operations at once feasible, pecuniarily profitable, and directly useful.

We shall present this plan after a brief notice of the steps which have led us to its conception.

As "compensation in kind" the United States Commission recommended that the occupation of South Boston Flats

should be immediately followed by the dredging away of flats and marsh lands in Mystic and Charles Rivers; but as a preliminary step to the opening of these new receptacles for tide-water, they declared that *an improvement of the outlets of these rivers would be indispensable*. It is precisely here that the impracticability of their plan presents itself. The encroachments upon the mouths of the Mystic and Charles Rivers have already rendered them insufficient for the free ingress and egress of river and tide-water. It is a fact, that we shall hereafter state more specifically, that these outlets have been so confined by wharves and bridges, that large masses of mud and sand have been torn from their beds by the current, and swept into the harbor. In order to make these avenues of communication sufficiently ample to accommodate an increased flow of tide-water without further disturbance of the beds, either the wharves and bridges must be in part removed, or the new regimen anticipated by artificial excavations to a great depth. Either of these provisions would consume the larger part of the profits anticipated from the reclamation of South Boston Flats, before any actual compensation could be charged to the account. We speak within bounds when we declare that *the expense of a proper transfer of the tide-water from South Boston Flats to interior basins would exceed the cost of removing all the bars and shoals from the Main Channel and the further cost of maintaining this channel in its improved condition forever*. We therefore, suggest that instead of expending vast sums upon these reservoirs and their outlets, and waiting many years for improvements to develop themselves in the harbor below, the more prudent course would be to expend the money directly upon the Main Channel in dredging, especially as every shovelful of earth taken from the bed of the channel will be available for filling upon the flats. The proposition we would offer as a basis of a feasible plan, is as follows:—

As soon as the wall has sufficiently advanced to offer proper protection to the filling, dredging shall commence in the Main Channel, and the material be used for reclamation until the flats in front of the wall are wholly removed to the depth of twenty-three feet at mean low-water and the Anchorage Shoal also excavated to same depth. And, furthermore, from the profits arising from the sale of reclaimed flats, the sum of

\$500,000 shall be funded and the interest used in repairing the damages which may arise from reduced tidal volume, and in maintaining the depth generally of the Main Channel. This proposition has the hearty sanction of the U. S. Advisory Council, as appears by their opinion, to be found in the Appendix to this Report.

On the plan of 1866, annexed to this Report, the space in the Main Ship Channel, colored red, indicates the shoal ground which we propose shall be removed. If we add to the amount of dredging we propose, the material of the upper middle which the United States government has provided for removing and which may be offered for filling also, we have a total of 3,547,100 cubic yards.

Should our proposition be adopted and the whole plan of improvement carried out, as we earnestly hope it may be, the Main Channel will be freed from obstruction, and a fair and ample water-way offered to first-class ships at all times of tide.

We have, in the course of our remarks on compensation, referred to changes in the bed of the harbor due to encroachments, without pausing at the time to furnish evidence of our statements, because we designed to take this important matter up separately.

CHANGES IN THE BED OF BOSTON HARBOR.

We are indebted to our Advisory Council for a valuable report upon this subject which appears in our Appendix. The laborious work, which forms its subject had been commenced by the United States Commissioners, and we very gladly accepted the proposal of the U. S. Council to complete it and bring all the facts to light. To this end, we supplied all the assistance required.

Two general results are reached, which, although striking in themselves, are rendered especially important by the inferences to which they lead:—

1. In the clear water-way of the Upper Harbor, the volume has remained the same.

2. The changes that have occurred are those due to the transportation of mud, sand, &c., from one portion of the harbor to another.

At the outlets of the interior reservoirs, scour has been induced by the undue encroachment of wharves, bridges, &c., and the material torn from the bottom has been swept down to broader and more valuable portions of the harbor basin.

From the first result, the fair conclusion may be drawn, that *the natural forces of the harbor are equal to the task of purging its channels of all foreign matter or its equivalent; and the second result justifies the conclusion, that an augmentation of the power by the enlargement of interior tidal reservoirs, requires, as a preliminary step, a great enlargement of the outlets, either by removing wharves and bridges or by excavations on a large scale.*

The objection to "compensation in kind," implied in the preceding sentence, was entertained by the United States Commission, and discussed by them at some length, especially as regards the Charles River, where they proposed a radical reform of the bridge system. In the case of the Mystic, the United States Commission proposed artificial enlargement of outlet section by dredging; they, however, made their suggestions under the impression that no further encroachments would be suffered, and that improper grants, already made, would not be extended.

In the interval between 1835 and 1861, during which many wharves and bridges were built, there disappeared from the bed of the Charles River, below Cragie's Bridge, over 260,000 cubic yards of material; and from the bed of the common outlet of Mystic River and Chelsea Creek, over 526,000 cubic yards.* The deepening in the Charles River mouth, has been totally useless, since there was ample depth of water before; and the local advantages gained in the Mystic Outlet, are very small compared with the amount of scour executed.

Below these localities there are spaces, here and there, in which deepening has occurred, but the shoaling is in great excess. The material from above, instead of being equally distributed over great areas, shows a disposition to aggregate in masses, and often in valuable portions of the basin. For instance, below the contraction, between Boston and East Boston, where the water space suddenly expands, there is a district, mostly in the Main Channel, in which the surplus of deposit

* In the arm of the sea above the projecting angle of the Navy Yard, and below Chelsea and Meridian Street Bridges.

over excavation amounts to an annual increase of 110 cubic yards to the acre.

Along the outer border of South Boston Flats, from Long Wharf to Slate Ledge, the average annual rate of deposit has been recently, 120 cubic yards to the acre.

As the different surveys examined did not extend over precisely the same ground, it is difficult to determine with precision the total amount of shoaling that has occurred; we have therefore confined our statement to well defined localities. From the best determination we can make, however, there appears to have been about 1,900,000 cubic yards of shoaling in the Upper Harbor, below the bridges, between 1835 and 1861. Much of this has occurred in places where it is already too shallow for navigation or still too deep to offer obstruction. Perhaps the portion which has been most injurious, is that which has fallen in depths of eighteen to twenty-four feet, because between these depths removal by dredging must be resorted to at great expense.

We call attention to the diagrams, annexed to the report of the Advisory Council, which combine table and map, and convey to the eye the localities that have suffered change, with the manner and amount of this change in any particular place.

On the 21st of August last, we addressed a communication to Prof. Benjamin Peirce, Superintendent of the Coast Survey, asking information relative to the derivation of the materials forming the shoals of Boston Harbor. Prof. Peirce kindly responded to this call by directing one of his assistants, Mr. L. F. Pourtales, an accomplished naturalist, to examine our specimens of the harbor bottom and report upon them.

Mr. Pourtales joined us at once and entered upon his task with cordial good will. His report, now on our files, frankly states his inability to discover the recent sources of the material forming the shoals and bars, but contains a valuable discussion of the physical features of the harbor. In this connection he makes the following statement:—

“The islands are generally covered with drift, so that the subjacent rock is rarely exposed to view, except the general strike of the ledges which form this skeleton, by the direction of their longer diameters, or by their arrangement in lines. The direction of the strike is nearly N.

E. and S. W. Red lines on the map show the best examples.* Thus we have one of these lines passing through South Boston heights, Governor's Island, Apple Island, Snake Island and Winthrop Head. The shoal ground of the Upper Middle forms part of this system. Then we have Thompson's Island and North Spectacle Island; next, Squantum, Moon Island and Long Island, the range continuing through Alderidge's Ledge to Green Island and the Graves, Half Moon Island, Peddock's Island, Grape and Bumpkin Island, Strawberry Hill and Harding's Ledge. The examples might be multiplied to a much greater number among the ledges of Cohasset, and still better, perhaps, at Nahant, where the rocks being more denuded, show both strike and dip very plainly, as was shown to me by Prof. Agassiz."

Mr. Pourtales' failure to discover the derivation of the deposits is explained, now that we are informed by the inquiries of our Advisory Council, that *the shoaling is nearly all of it a mere shifting of the material—not deposit from foreign sources.*

Our advice to the legislative committee upon the subject of compensation was based upon the foregoing considerations and our recommendations agreed to. Accordingly the committee presented to the Board a proposition drawn up by the two bodies in concert, which was adopted by the Board in the following vote:—

"Whereas, The committee appointed under chapter 93 of the Resolves of 1867, have agreed to provide in any contract for filling the South Boston Flats, and for dredging a portion of Boston Harbor, as shown by a plan hereto annexed, to the depth of twenty-three feet below low-water, and using the material thus dredged in filling section 1 of South Boston Flats; and

"Whereas, Said plan having been laid before the Harbor Commissioners (and the United States Advisory Council, represented by Mr. Mitchell,) and approved by the Harbor Commissioners, as a full equivalent for compensation for tide-water displaced in filling section 1; therefore;

"Resolved, That an account, including interest, shall be kept by the Commonwealth of all moneys paid on account of filling the South Boston Flats, and of all moneys received for sales and use of the same; and, so far as it shall be proved by hydrographical and physical surveys, that the harbor has been injured by said filling, over and above the benefit to the harbor resulting from the excavations for the purpose

* The map, we regret to say, is incomplete. We should have added it, and the paper to our Report, but for this.

of said filling, the Commonwealth shall be bound to repair the injury by dredging or otherwise: *provided*, that the expenditure for this purpose shall not exceed in all the net receipts by the Commonwealth from the sales and use of said flats, with interest thereon."

We have stated in this Report the requisite guarantee of the Commonwealth in the form of a fund to be set apart, as defining more clearly what such a guarantee will imply and the form in which it would be most desirable.

CHARLES RIVER.

The selectmen of the towns of Newton, Watertown and Brighton, have requested the Commissioners to cause surveys to be made of the upper reaches of the Charles River, from Watertown Arsenal to the Newton and Watertown bridge, with a view to ascertain what tidal compensation could be obtained by dredging. The bed of the river being on an average from three to four feet above mean low-water, navigation is greatly obstructed. A deepening of the bed, a work in which the inhabitants of these towns are greatly interested, it was found would facilitate navigation to Watertown. As the work desired was to be done at the expense of the petitioners, we caused the surveys to be made by our engineer.

BRIDGES.

The attention of the Board has been often directed to the bridges from Boston across Charles River. The bridges are direct and serious obstructions to navigation; and the piles so confine the outflow and delay the tidal currents, that an unnatural scour is induced, which has caused the bed of the stream to give way, and masses of material to escape into the harbor basin. These evils are increased by the bad construction of most of the bridges, of which the rows of piles, instead of being driven in the same direction as the current, cross it at every variety of angle.

Bridges being a necessity, the unavoidable evils which result from them must be endured. But, whenever a bridge is to be rebuilt, the work should be done in such a manner as to do the least injury to the harbor.

The Board attended a meeting called by the committee appointed at the last session of the Legislature, to consider the

best mode of providing means for sustaining the expense of keeping the bridges between Charlestown and Boston in repair.

A plan which had been voted down by the House of Representatives last year, was again urged before the committee. The plan was to erect buildings on both sides of the bridges, to be supported on piles driven into the bed of the river, and to employ the rents of these buildings in sustaining the bridges. We protested, as we had at the last session before the Committee on Harbors, against this new and needless attack on navigation and commerce, and insisted that any mode of taxation for supporting the bridges would be better than this; that it was enough for the harbor to endure the necessary bridges, without being subject to this new burden. Several speakers before the committee recommended, instead of the two bridges, a single bridge, supported by stone piers, with broad spans, a double draw and two roadways at the draw, so that the passage over the bridge should never be interrupted for a moment by a vessel passing through the draw. The general plan meets our cordial approbation, as conservators of the harbor. If executed, it would improve navigation by substituting one good bridge for two defective ones, and by assisting the flow of the water by piers built in conformity with the current of the river. But we have not matured any definite plan so as to bring it before the legislature, either as to the exact place for building, the construction, the cost, or the mode of defraying the cost.

LYNN HARBOR.

The results of the survey of Lynn Harbor for the purpose of establishing harbor lines, have led us to make some suggestions to the city council of Lynn for the improvement of their harbor, by constructing a rip-rap breakwater across the mouth of the harbor, dredging a deep basin in front of the new wharf line, and filling up certain flats and marshes with the dredged material. The proceeds from the sales of land created in this manner, would defray the cost of the harbor improvement herein suggested. The city authorities have considered the plan favorably; and we have reason to believe that the suggestions will be acted upon at no distant day, and

that the result will be, greatly to increase the prosperity of Lynn.

SALEM HARBOR.

Upon application of the Board of Trade of Salem, our engineer was directed to examine into the condition of certain portions of Salem Harbor, which offer obstructions to navigation. From his survey, it appears that the approach to "Derby Wharf,"—now the most important wharf of the city,—requires to be deepened by means of dredging to the amount of 49,600 cubic yards; and also that Long Point needs protection by the construction of a breakwater 550 feet long. The subject is still under consideration by the Board.

CAPE COD HARBOR.

On the 24th of April last, the Commissioners gave a hearing to the citizens of Provincetown upon the subject of establishing harbor lines. The physical features of the harbor indicated to us the course to be taken in laying down the lines. They were established about two thousand feet from the shore, in general conformity with the line of the shore, giving ample depth to shipping at the ends of the wharves.

The map of the harbor was prepared, without delay, from the surveys of our engineer, and the lines were established by an Act of the legislature, approved May 24, 1867.

WORKS APPROVED.

Plans have been approved by the Board for building wharves in various harbors of the Commonwealth under the authority of the legislature, namely, in Boston, Gloucester, Hull, Hingham and Dorchester. The Board have also approved plans for the widening of Federal Street Bridge, the Old Colony Railroad Bridge, the Fitchburg Railroad Bridge, the laying of syphons to conduct water from Charlestown to Chelsea, across Mystic River, and from Wenham Lake to Salem, across Essex River.

LEGAL PROCEEDINGS AUTHORIZED BY THE BOARD.

The Board have also taken action to prevent the Boston Wharf Company from building upon the flats under the license which the last legislature revoked by section 4 of chap-

ter 354 of the Acts of 1867, and directed the attorney-general to obtain an injunction to prevent the erection of any structures thereon. An information was filed accordingly by the attorney-general. The answer of the defendants denies the constitutionality of the Act of 1867 revoking their license. A decision of the question will probably be obtained before the adjournment of the legislature.

Upon application of the selectmen of Medford for the removal of Wood's Dam across Mystic River (which had been removed by the city of Charlestown upon an order of the governor and council, and subsequently rebuilt by the owner,) the Board directed the district-attorney for the county of Middlesex to institute legal proceedings on the ground that the dam was a public nuisance, and he has done so.

COMPENSATION FUND.

The compensation fund for Boston Harbor, provided for in section 4, chapter 149 of the Acts of the year 1866, amounts at the present time to \$8,857.81.

We cannot close this Report without expressing our appreciation of the efficient services of our Engineer, Mr. Albert Boschke, and acknowledging the great aid and valuable counsel we have received from the distinguished men who compose the U. S. Advisory Council. This Council now consists of Rear Admiral Charles H. Davis, of the United States Navy, General A. A. Humphreys, Chief Engineer of the United States Army, Professor Benjamin Peirce, Superintendent of the United States Coast Survey, and Mr. Henry Mitchell, an assistant of the Coast Survey, a gentleman of high attainments in hydrographical science. Professor Peirce is a recent accession to the Advisory Council, which is of the utmost advantage to the Board. He brings to us a profound knowledge of the problems of physical science and their mathematical solutions, which has given him a world-wide fame. He had already indicated his interest in and appreciation of the importance of the duties assigned to us by permitting his assistant, Mr. Henry Mitchell, to devote much of his time to our work, in the performance of which he has done credit to the service to which he belongs and the Council he represents. We regret to announce that General Richard

Delafield has found himself obliged by official duties to dissolve his connection with the Council. We desire to add, that although the State Engineer, Mr. George R. Baldwin, was in no way responsible to this Board for his work during the past year, our relations with him have been of a most friendly and agreeable character.

JOSIAH QUINCY,
S. E. SEWALL,
WILLIAM MIXTER,
DARWIN E. WARE,
F. W. LINCOLN, JR.,
Board of Harbor Commissioners.

BOSTON, January 13th, 1868.

A P P E N D I X .

R E P O R T

ON THE REMOVAL OF OBSTRUCTIONS FROM THE HARBOR, AND THE
BUILDING OF WALLS TO PROTECT THE HEADLANDS, BY BREVET
MAJOR-GENERAL J. G. FOSTER, U. S. ENGINEER.

BOSTON, MASS., January 9th, 1868.

Hon. JOSIAH QUINCY, *Chairman of Board of Harbor Commissioners:*

SIR,—In compliance with your request, I herewith give a brief account of the operations in improving the Harbor of Boston since the 1st of June, of last year, at which time I took charge.

The total amount appropriated for the works under my charge during the fiscal year ending the 30th of June, 1868, was . . . \$300,000 00

This was assigned by the chief engineer, according to the original estimates, as follows:—

For sea-wall for preservation of north head of Long Island,	\$75,000 00
For sea-wall for preservation of Gallop's Island, . . .	50,000 00
For sea-wall for preservation of Point Allerton, . . .	50,000 00
For dredging Lovell's Island Spit, Great Brewster Spit and Upper Middle Bar,	160,000 00
For removing Tower Rock and Corwin Rock,	20,000 00

Sea-Wall for Preservation of North Head of Long Island.

The title to the site not having been secured by the officer having the matter in charge, no work has been done, and no progress made except in the preparation of the plans and estimates for the sea-wall. It is understood that the site cannot be obtained until the passage of an Act

by Congress providing for taking it by the exercise of the right of eminent domain. It is expected that this will be done this winter, in season for the making of the necessary contracts, and the commencement of the work in the spring.

Sea-Wall for the Preservation of Gallop's Island.

As this island was the property of the city of Boston, application was made, September 4th, to the proper city authorities for the transfer to the United States of certain portions of the island necessary for the erection of the sea-wall, and for the occupation of such other portions as might be necessary for carrying on the work, and for the storing and preparation of the material to be used in it. The necessary orders were passed by the common council, September 26th; by the board of aldermen, September 30th, and approved by the mayor, October 1, 1867. The requisite deed was executed by His Honor, Mayor Norcross, December 4, 1867. As soon as the plans and specifications are completed, proposals will be advertised for and contracts made in season to commence the work early in the spring.

Sea-Wall for the Preservation of Point Allerton.

Leases were secured of the land necessary for the construction of the sea-wall, which have, however, not been approved by the chief of engineers, who decides that no structure can be placed upon land not owned by the United States in fee simple. No portion of the appropriation in my hands can be, under the law, appropriated to the purchase of the site. In other cases of protection of the islands and headlands in this harbor, the State or city has transferred to the United States the land necessary for the purpose. I hope the same course may be pursued in this instance.

I would suggest that the legislature of the State of Massachusetts take, by the exercise of the right of eminent domain, so much of the land at that point as may be necessary for the construction and future repairs of the sea-wall, and transfer the same to the United States for this purpose. If this be done by the State at an early day, the work may be commenced in the spring, as the plans and specifications for the work will be completed before that time.

Dredging of Lovell's Island Spit.

A contract was entered into on the 13th of July for the removal of 145,000 cubic yards, by dredging, to the depth of 23 feet at mean low-water, and to cut off the extremity of the Spit in a line generally parallel to the axis of the channel at that point. The estimate comprised

the widening of the channel at that point from 360 feet, its width at that time at the end of the 18 feet curve, to about 500 feet, for which the amount available at present was estimated to be sufficient. The work has been carried forward by the contractor with great energy, in spite of many obstacles, and with such success, that up to the time of suspending work for the winter, on the 30th of November, 53,453 cubic yards had been excavated and removed, causing a considerable improvement in the channel even thus far, and a sensible increase in the duration of the ebb tide at that point. The full value of the improvement will not be felt until the entire completion of the cut, which will not probably occupy more than two months in the spring. A further increase in the duration of the ebb tide is then anticipated, which will tend to preserve the improved width of 500 feet, and even to increase it. A further appropriation of \$130,000 has been asked for in my report to the chief of engineers, of September 5th, 1867, for the purpose of extending the dredging at this point, so as to widen the channel to 685 feet at the 18 feet curve, and to dredge it to the uniform depth of 23 feet at mean low-water. This is in accordance with the original estimates of the Harbor Commissioners. I inclose a copy of the sketch which accompanied the original estimates, showing the nature and value of this improvement, upon which has been graphically shown the amount of material removed during the past season.

Amount expended on this work to date, . . .	\$24,412 37
Amount available on hand and in treasury, . . .	48,087 63

Dredging Upper Middle Bar.

A contract was entered into on the 12th of July, 1867, with Mr Charles Woolley, of Boston, to dredge 40,000 cubic yards of material from the channel across this bar, making a straight cut along the centre of the channel to the depth of 23 feet at mean low-water, and as wide as the limit of the contract would allow. After a short trial, Mr. Woolley abandoned the work, and refused to comply with the terms of the contract. A new contract was then made on the 28th of September, 1867, with Mr. William W. Wright, of Geneva, N. Y. The delay caused by the failure of Mr. Woolley, and the difficulty experienced by Mr. Wright in procuring, at that late period in the working season, suitable dredges, prevented any work being done this season. Mr. Wright has made arrangements to commence work as soon as the weather in the spring will permit. A further appropriation of \$110,000, sufficient to dredge this channel to a width of 1,000 feet, and depth of 23 feet at mean low-water, according to the original estimates of the Boston Harbor Commissioners, has been asked for in my report to the

chief engineer, of September 5, 1867. If the appropriation be obtained, it will effect a very great improvement in the navigation of the harbor, and will accomplish all that is absolutely required at that particular point.

Blasting and Removing Tower and Corwin Rocks.

A contract was entered into on the 10th of July, 1867, with Mr. George W. Townsend, to perform the work for a specified sum per day, he to furnish a suitable vessel and crew, two sub-marine divers, drilling machine, electrical blasting apparatus, and all the material and appliances necessary in the prosecution of the work. Work was commenced on the 29th of July upon Tower Rock, which, being the smaller, it was decided to remove first. This rock was found to be an argillaceous slate, of firm, compact texture, smooth upon its surface, and of 26 by 51 feet extent, horizontally, at the depth of 23 feet below low-water, to which point it was decided to remove it. The situation of this rock being only 100 yards south-west from the Bug Light, and upon the edge of the Main Ship Channel, and the depth of water upon it 19 feet at low-water, made it a serious obstruction to navigation, although not so dangerous as Corwin Rock, which was situated 100 yards further south-west, and almost in the centre of the channel, and had only 16 feet of water upon it at low tide.

The accompanying sketch shows the relative positions and dimensions of the rocks.

Work was steadily continued until the 29th of September, when Tower Rock had been entirely removed to more than the required depth, over eighty tons of stone, in large pieces varying from one to eight tons, were hoisted up and deposited on shore, and about seventy tons more of smaller pieces were suffered to remain on the bottom around the rock where they had been blown by the blasts. This result was obtained by blasting in holes drilled for the purpose by the use of a machine specially designed for this kind of work. It is attached firmly to the rock, and operated by suitable connection with steam power on the deck of the working vessel. The working of the drill, and all operations under water, were attended to by the sub-marine divers. Careful provision for the rise and fall of the tide and the swell of the sea having been made, enabled the operations to be carried on in all except the roughest weather. Similar provision having been made for quickly leaving position in cases of sudden danger from collision or stress of weather, very few accidents occurred, and those of a trifling character.

After finishing Tower Rock, the working vessel was moored over Corwin Rock, and work commenced for its removal on October 1st, and

steadily continued until the recent heavy storm forced the work to be discontinued for the winter. The progress has not been as good upon this rock as upon the Tower Rock, for the reason that its structure is peculiar, its laminæ being twisted and contorted in every direction, so that it breaks at the blasts into small fragments, difficult to remove on account of the time required to gather and hoist them up in tubs. Notwithstanding these difficulties, the southern half of Corwin Rock has been removed, comprising about two hundred tons, a large portion of which has been hoisted up and deposited upon the beach. Four months' work in the spring will complete the entire removal of this rock, which has been a very dangerous one for navigation, very many vessels having struck upon it as is evinced by the large quantities of copper and lead, pieces of keels of vessels, anchors, shoes of vessels, &c., found upon it and in its crevices.

Amount expended on Tower Rock,	\$5,194 71
Amount expended on Corwin Rock to date,	5,036 92
Available on hand and in treasury,	9,768 37

Trusting that the above, with the accompanying sketches, may convey a sufficiently clear idea of the operations for the improvement of Boston Harbor,

I remain, very respectfully,

Your obedient servant,

J. G. FOSTER,

B'vt Maj. Gen'l U. S. A., Lt. Col. Eng'rs.

L E T T E R

FROM BREVET MAJOR-GENERAL H. W. BENHAM, RELATIVE TO SEAWALLS IN BOSTON HARBOR.

BOSTON, December 26, 1867.

Hon. JOSIAH QUINCY, *Chairman of State Harbor Commissioners:*

SIR,—In reply to a note from your Board dated the 21st inst., I have the pleasure of giving you the following information in relation to my “work in Boston Harbor during the past year, under the congressional appropriation of seventy-five thousand dollars.”

This appropriation, which appears to have been a part of a larger sum granted upon an estimate which had been previously sent to me to report upon, has been held available, as estimated for by me in my annual report of 1866, for the sea-walls, Great Brewster, Deer and Lovell’s Islands—\$25,000 for each—and to be expended only after former appropriations were exhausted.

After the former appropriations for the *Great Brewster Island* were exhausted, in August last, a *contract* was advertised for, and made, as required by the law, for the continuance of the main wall of the north head of this island, and the wall has been carried on as far as these funds (\$25,000) have permitted; resulting in the laying of about 430 linear feet of wall, having a stone facing of 16 feet high, above the foundation of concrete, of $2\frac{1}{2}$ feet depth. This completes the main wall that is now deemed necessary for the protection of the north head of that island. But I regret to say that the funds did not suffice for the earth filling in rear of the last 550 feet of wall laid, or for the laying of the heavy paving required upon the north head, the stone for which is for the most part on hand.

I am not certain if your Board desire a further report than is given above, which relates to the only portion of the \$75,000 as yet expended,—the other sums for Deer and Lovell’s Islands being yet held in the treasury, as the former appropriations for these works are not as yet quite exhausted. But as perhaps a brief summary of the work thus

far executed under recent appropriations may be desirable, I would respectfully append it herewith.

The wall now constructed at the south head of the Great Brewster Island, and which gives that bluff ample protection, is about 920 feet in length, fully three-fourths of this having the stone facing 18 feet in height, and the remainder 16 feet high, with concrete backing to about 8 feet in width and with a concrete foundation $2\frac{1}{2}$ feet deep. This is well paved in rear for 14 to 18 feet in width for its whole length.

The wall of the north head is 1,720 linear feet (making 2,740 feet on both heads,) and of this about 1,340 feet has a stone facing 18 feet high, the remaining 400 feet having the stone facing averaging 16 feet high with concrete backing and foundation as above described for the south wall.

There is further required to complete the protection to this island, a wall of 250 linear feet of about the same size as above, to connect the walls of the two heads, to prevent the island being cut in two. And for the completing of the paving and filling at the north head, and one or two jetties, for which my estimates are \$34,000, if left to the officer to judge of the best method of executing the work, or \$50,000 if he is limited by the law to the execution of this work by contract only.

As to the work at Deer and Lovell's Islands, the former appropriations have sufficed for the work as carried on at these places, up to this time; though but a few thousand dollars now remain on hand of those former appropriations. The \$25,000 for each of these works, from the sums last appropriated, of course now remain undrawn in the treasury. During this past season, at Deer Island the south half of the wall at the middle head, about 17 feet high, has been relaid with a concrete backing for some 8 feet in width, for about 360 linear feet; being with that on the north part, relaid in 1866, (all except the north wing wall,) the whole at this head that now appears necessary to rebuild. And the wall of the south head (about $16\frac{1}{2}$ feet high,) has been relaid or rebuilt for its whole extent, or for 440 feet; or, there has been relaid this season at Deer Island about 800 linear feet of wall.

At Lovell's Island a contract has been advertised for, and made, for the cut stone facing of about 750 linear feet of 8-foot wall for the bluff of the south-east head, the greater part of which is now received and on hand ready for laying at the opening of the next season. There were no serious injuries occurring at the island to require indispensable any other work there during the past season.

For the construction of the wall with the 8-foot stone facing at south-east bluff of Lovell's Island, with some other work on the jetties and wing walls on the old north head wall of Lovell's Island, and for the

rebuilding of about 1,440 linear feet still required it at the north head of Deer Island, I estimate as necessary, in addition to what is now on hand, about \$24,000, if constructed as heretofore by days' works, under supervision; or if required to be done by contract, as by the last law, at least \$36,000 will be necessary, in my judgment.

I am, Sir, very respectfully,

Your most obedient servant,

H. W. BENHAM,

Br't. Maj. Gen'l U. S. A., and Supt. Eng'r of Forts and Sea-Walls, Boston Harbor.

REPORT

OF THE UNITED STATES ADVISORY COUNCIL TO THE BOARD OF
HARBOR COMMISSIONERS UPON RECENT CHANGES IN THE BED OF
BOSTON HARBOR, TO WHICH IS ADDED AN OPINION UPON COM-
PENSATION.

Hon. JOSIAH QUINCY, *Chairman of Harbor Commission:*

DEAR SIR,—With the ample facilities placed at our command by your honorable Board, we have succeeded in making a comparison of the surveys of Boston Upper Harbor, and have reached some positive results. We have confined our attention to the following late surveys:—

A survey of the portion of the Upper Harbor lying above the Anchorage Shoal, including the lower portions of the Charles and Mystic Rivers, executed under the direction of the first State Commission, in 1835.

A survey executed for the United States Coast Survey, by Lt. Commanding (now Rear Admiral,) Charles H. Davis, in 1847.

A survey of the harbor executed for the United States Commission, by A. Boschke, Esq., Engineer of the Board, in 1861.

In the surveys of 1835 and 1861 the soundings are quite as numerous as a comparison of depths requires. The survey of 1847, having been designed for purposes of navigation more particularly, does not furnish so many data as the two above referred to, as far as regards the Upper Harbor.

In making our comparisons, we have used plottings of the three surveys prepared for the United States Commission by Mr. Boschke several years since, all of them upon a scale of 1=10,000. We have attempted to present a view of the changes which should convey to the eye the *amount* and the *locality* at the same time. To do this we have been obliged to combine table and map in each case, by superimposing the one upon the other. (See Diagrams I, II. and III., annexed.) An outline sketch of the harbor has first been traced from the most recent survey, and afterwards spaced off in equal squares to receive the figures

indicating the number of cubic yards of deepening or deposit. Each square covers a little short of an acre, (3,721 square metres,) and the figures within are written in blue or black ink,—the former for deepening, the latter for shoaling.

The surveys examined are works of merit, the comparisons we have made are careful, and yet the tables must not be too critically accepted. It is not claimed that each particular square contains a statement absolutely true, or that it represents anything like a permanent condition or process of change. For instance, a vessel lying at anchor, by compelling the current to descend may cause a deepening beneath her and a shoaling behind her. Such a change would appear as an isolated one upon our diagram and be entitled to no importance; but where the squares of shoaling or deepening appear in groups of three or more the general result may be relied upon; and where these recur upon comparisons of different periods, a degree of certainty and importance attaches itself to the fact.

Upon each diagram the general summing up is entitled to confidence. We have used all our data without selection, believing it better to trust to the canceling of errors by large aggregations than to attempt an exercise of judgment. If, however, we had rejected all quantities which do not appear in groups of the same signification, we should have reached the same results.

We shall introduce our comments upon the diagrams by the statement of general results in the form of propositions and their corollaries, and afterwards proceed to a general review of the evidence upon which they rest.

1. The volume of the Upper Harbor, below the plane of mean low-water, remained essentially the same from 1835 to 1861.*

2. By the confinement of the natural forces in the harbor due to artificial encroachments,—mostly those at and near the mouths of the rivers,—large changes of the bed have been induced, and the material excavated at one point has been cast down at another, to the injury of valuable portions of the harbor. The mouth of the Charles River, before quite deep enough for all the possible wants of commerce, has been scoured still deeper; and the outlet common to Mystic River and Chelsea Creek, has yielded large supplies from its bed, and with comparatively little local advantage. These supplies of material are found deposited in the harbor basin,—not equally distributed over great areas, but accumulated in masses, some of which have chosen the most

* This statement is to be understood as applying to the clear water-way, below the tributary basins, as far as actually covered by our figures. We have no data for comparing the volumes within the slips or beneath wharves, new and old.

valuable anchorage sites and are approaching the critical paths of navigation.

These two results lead immediately to inferences of grave importance, viz.: *that the tidal reservoirs engender sufficient power to purge the harbor channels of foreign matter or its equivalent; and that any augmentation of the interior reservoirs, in the present encumbered state of their outlets, would do more harm than good.*

The United States Commissioners were aware of these difficulties in the way of "*compensation in kind*," but did not realize their full magnitude. They believed that the outlets of the reservoirs could be improved by a reduction of the number of bridges, and by a radical reform in their mode of construction, and that the new regimen could otherwise be anticipated by enlargements of outlet sections with the use of the dredge.

3. In comparing the tables covering the two periods between the surveys, we are able, in a general way, to identify one large mass of material, and witness its emergence from the deep and contracted pass between Boston and East Boston, and its approach to the shallower expanse below; and to observe that, as this bank advances, the original depth behind it shows a tendency to recover itself. We mention this because it will strike you at once on looking at the tables, and we would warn you against inferences which might seem to follow, but which to our mind are unsafe. It does not follow that a moving mass like this represents the total and final effect of an encroachment, nor does it follow that the movement of this mass is to continue till the material is thrown into the sea, or crowded out of the channel-ways on to the flats, or into the dead angles along shore. We have observed of sands, that they often travel on the bottoms of streams like dunes upon the shore, in successions of banks. It is true that we are not dealing with sands, properly speaking, in Boston Harbor, but still the movement of the material may follow some such rule. Again, we do not discover in the basin of the harbor, the proper order of forces to make the movement of any single bank continuous. We beg leave, in this connection, to call your attention to some remarks of the United States Commission, based upon very close observations and computations:—

"Boston Upper Harbor presents, as one of its worst features, a flood predominance in a portion of the Main Channel,—that portion which lies between Bird Island and South Boston Flats. The Upper Middle Bar upon the one hand, and the Anchorage Shoal upon the other, are the limits of this flood channel. These two banks are, in fact, the

debatable districts where the flood and ebb are equal in power. If we follow the ebb from the junction of the Charles and Mystic Rivers to the sea, we find no other break in its controlling power along the principal avenues; and that this break should occur in so valuable a portion of the harbor, we cannot but consider unfortunate,—not irremediable, however, by any means.*

* * * * *

“If we may not assume that these two banks which limit the flood channel have been formed in the contest of the ebb and flood forces, and that they are the sediments thrown down in the equal contests at their equilibrium points, we can at least assert that these banks are in no wise to be regarded as *causes* of the phenomena observed, and we see no reason to doubt that if the conditions should be changed so as to give entire mastery to the ebb, these banks would diminish if not disappear. At present there are no causes at work to wear them away; quite the contrary; we cannot see how *rolling* materials can pass them.”†

The United States Commissioners were not aware, when these statements were written, that the illustration of their truth was to be found already. In the comparison of the surveys of 1847 and 1861 two banks of new deposits appear, one just above the Anchorage Shoal, the other just above the Upper Middle Bar. Both of them stretch quite across the Main Channel, although they neither of them diminish the maximum depth in a serious manner.

To find the proof of the foregoing propositions, we have but to examine the aggregates of our tables. Taking the entire period of twenty-six years, the comparison shows that in the space between the Anchorage Shoal and the basins above the city, (whose limits we assume to be Cragie's Bridge, Chelsea Bridge, Meredian Street Bridge, and Boston, Hartford and Erie Railroad Bridge,) we have an aggregate deepening of 1,109,260 cubic yards, and an aggregate shoaling of 606,020. There are missing from this district, then, 503,240 cubic yards. If, now, we take the comparison of the surveys of 1847 and 1861 and compute the changes from the space below the limits of the previous comparison, we find the aggregate deepening 410,660, and the shoaling, 688,250, showing a surplus of deposits to the amount of 277,590 in this space during fourteen years. Supposing the rate of deposit uniform for the twenty-six years, we have to increase this sur-

* The remedy referred to is the enclosure of the South Boston Flats.

† Tenth Report United States Commission, pages 76 and 77.

plus to 515,528, which balances the account very closely. Some doubt may be entertained as to the uniformity of the rate of deposit, but we consider the supposition safe, because the comparisons of spaces covered by all three surveys, give in one case a larger and in the other a smaller deposit for the first than the second period. When the masses of material are travelling, a comparison for the determination of the rate of deposit is nevertheless uncertain.

In the mouth of the Charles River a useless scour has been induced. In 1835, a track could be found from the Navy Yard to Cragie's Bridge along which the minimum depth was twenty-five feet. A similar track in 1861 had a minimum of twenty-eight feet, and in the interval over 260,000 cubic yards had been scoured from the bottom and carried off.

In the common mouth of the Mystic River and Chelsea Creek, from Chelsea and Meridian Street Bridges down to a line drawn due east from the point of the Navy Yard, 526,140 cubic yards have actually disappeared; the deepening, in a selected space of seventy-seven acres, averages two and one-half feet, with a maximum of nine feet; and eighteen feet could be carried up this arm of the sea in 1861 against fourteen and one-half feet in 1835,—a decided improvement as far as it goes.

In order to exhibit the dangerous tendencies of the shoaling in the harbor basin, we have selected a space covered by all these surveys, in the most valuable portion of the harbor. We have drawn a square whose upper side is a line drawn from Commercial Wharf to Cunard Wharf, enclosing about one hundred acres, in which we find the following changes :—

Between 1835 and 1847, shoaling,	. . . . .	122,006
“ “ “ deepening,	. . . . .	50,550
Surplus deposit,	. . . . .	71,456
Between 1847 and 1861, shoaling,	. . . . .	199,073
“ “ “ deepening,	. . . . .	36,929
Surplus deposit,	. . . . .	162,144
Between '35 and '61, by comparison of first and last survey,—		
Shoaling,	. . . . .	289,040
Deepening,	. . . . .	11,100
Surplus for 26 years,	. . . . .	277,940

The disagreement between the final result and the sum of the two preceding, is to be attributed to the fact that the soundings upon the map of 1847 are not sufficiently numerous, and have therefore compared rather differently with the two other surveys, these comparisons having been made independently.

If the deposits were not evidently in motion, we should see no great injury thus far accomplished in this particular space. This portion of the harbor is deep, and the least water in the thread of the channel in 1861 was still about twenty-two feet. When this mass shall have worked down to the Anchorage Shoal, where the basin is broad, but the channel very narrow, we may expect trouble.

It would appear from the comparison of 1847 and 1861 that a large body of the material is disposed to distribute itself along the outer margin of South Boston Flats. If we construct a parallelogram whose upper side is a line from Commercial Wharf to Slate Ledge Buoy, and whose adjacent side, on the west, is a line from Commercial Wharf to Central Wharf, (south angle,) we inclose an area of one hundred and two acres, in which, during fourteen years, there was a shoaling to the amount of 178,898 cubic yards, and a deepening of only 11,670 cubic yards. So that there accumulated here, from external sources, 167,228 cubic yards.

The survey of 1835 does not cover the whole of our parallelogram, but goes far enough to show, by comparison with 1847, that deposits had commenced at the upper end of the space, but had proceeded but a short distance down. The 1847 survey has ample data for this comparison. Perhaps we ought to explain that we have felt obliged to confine our view to regular spaces, because the several surveys are not everywhere coincident, and because we thus avoid difficulties of description in great measure.

We shall close this Report with an opinion touching the occupation of South Boston Flats, which is based upon the investigations of the United States Commissioners, combined with our own inquiries.

OPINION.

We are satisfied that your proposition to use, in the reclamation of the "first section" of South Boston Flats, material dredged from the borders of the Main Channel—to the extent that may be required for the removal of the Anchorage Shoal and the flats lying beyond the "quay line" of the United States Commission, to the depth of twenty-three feet at mean low-water, and to the total amount of 3,233,000 cubic yards—may be accepted as adequate "compensation;" *provided*, that from the profits of this reclamation, a fund shall be reserved which

shall be sufficient to yield an annual interest of not less than \$25,000, to be expended by your Board in maintaining the depth gained in the Main Channel and in preserving the present depths elsewhere in this channel.

A. A. HUMPHREYS,

Brig., and Br't Maj. Gen'l U. S. A., Chief of Engineers.

BENJAMIN PEIRCE,

Superintendent U. S. Coast Survey.

HENRY MITCHELL,

Assistant U. S. Coast Survey.

U. S. Advisory Council to Board of Harbor Commissioners of Massachusetts.

PLAN
for the occupation of
FLATS OWNED BY THE COMMONWEALTH
IN
BOSTON HARBOR.

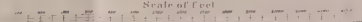
APPROVED AND ADOPTED BY THE GENERAL COURT.

May 18th 1866.

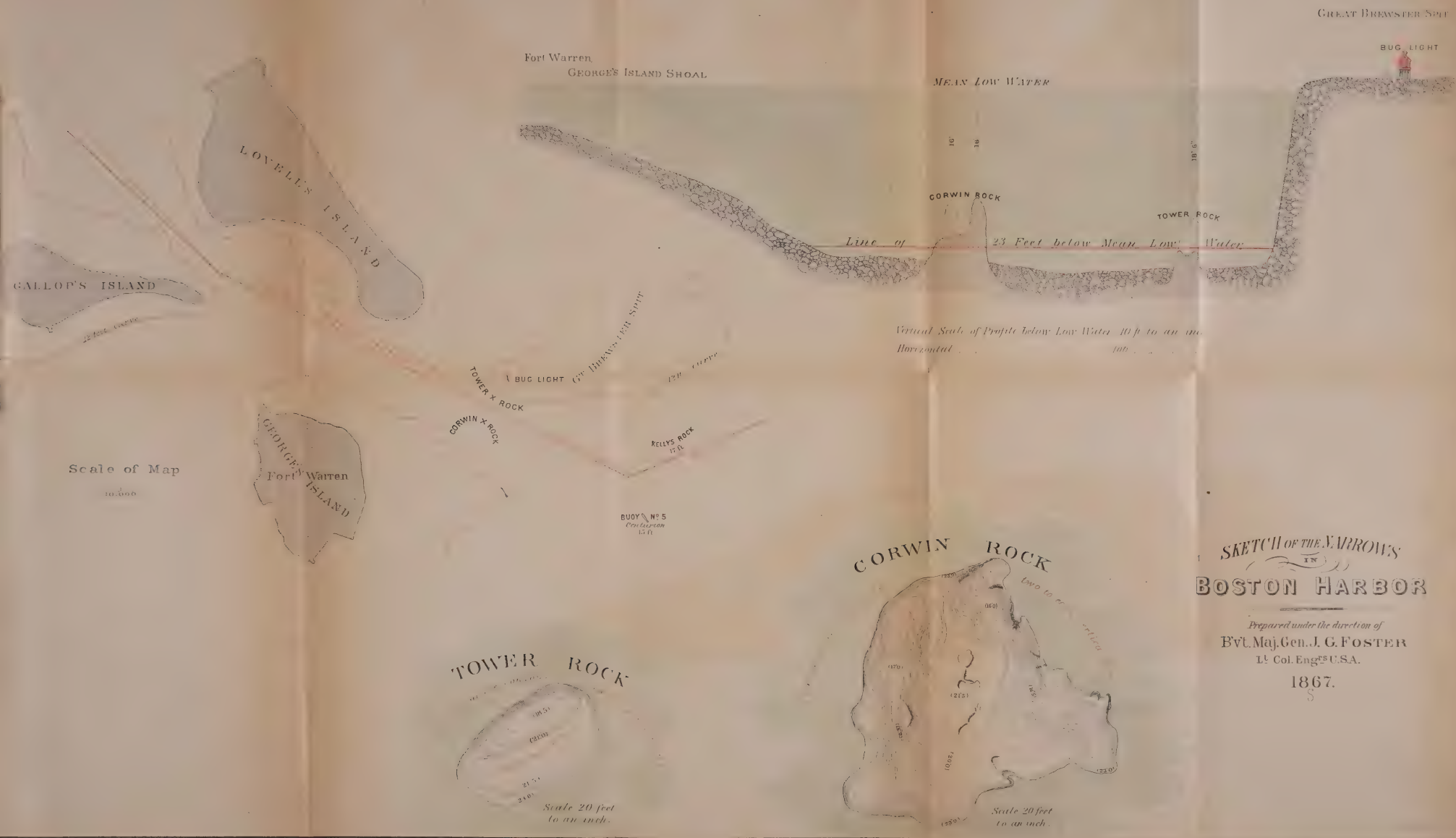
AND MODIFIED ACCORDING TO CHAP. 354 OF THE ACTS OF 1867.

SCALE 10,500

Scale of Feet



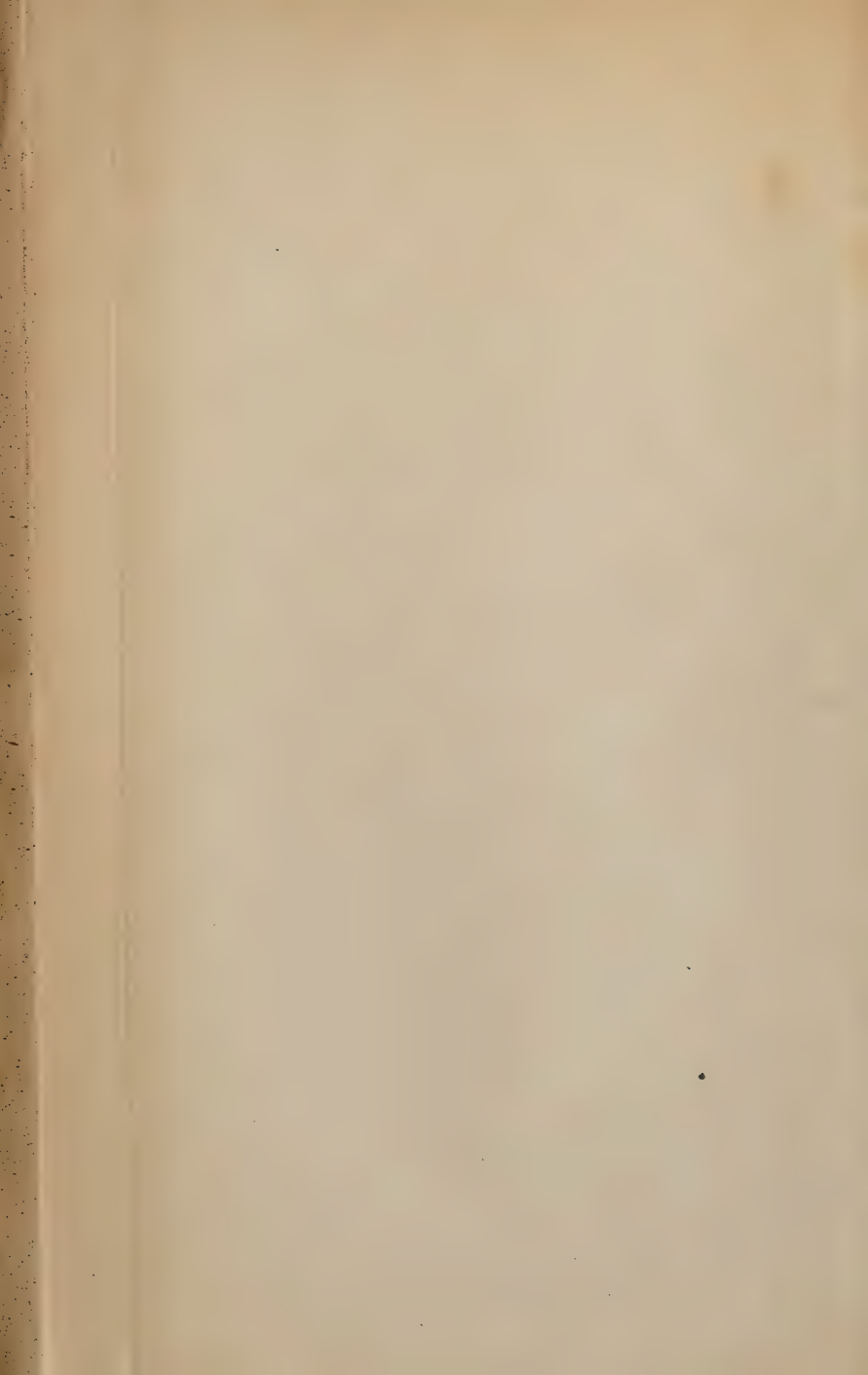




SKETCH OF THE NARROWS IN BOSTON HARBOR

Prepared under the direction of
Bvt. Maj. Gen. J. G. FOSTER
Lt. Col. Eng^{rs} U.S.A.

1867.



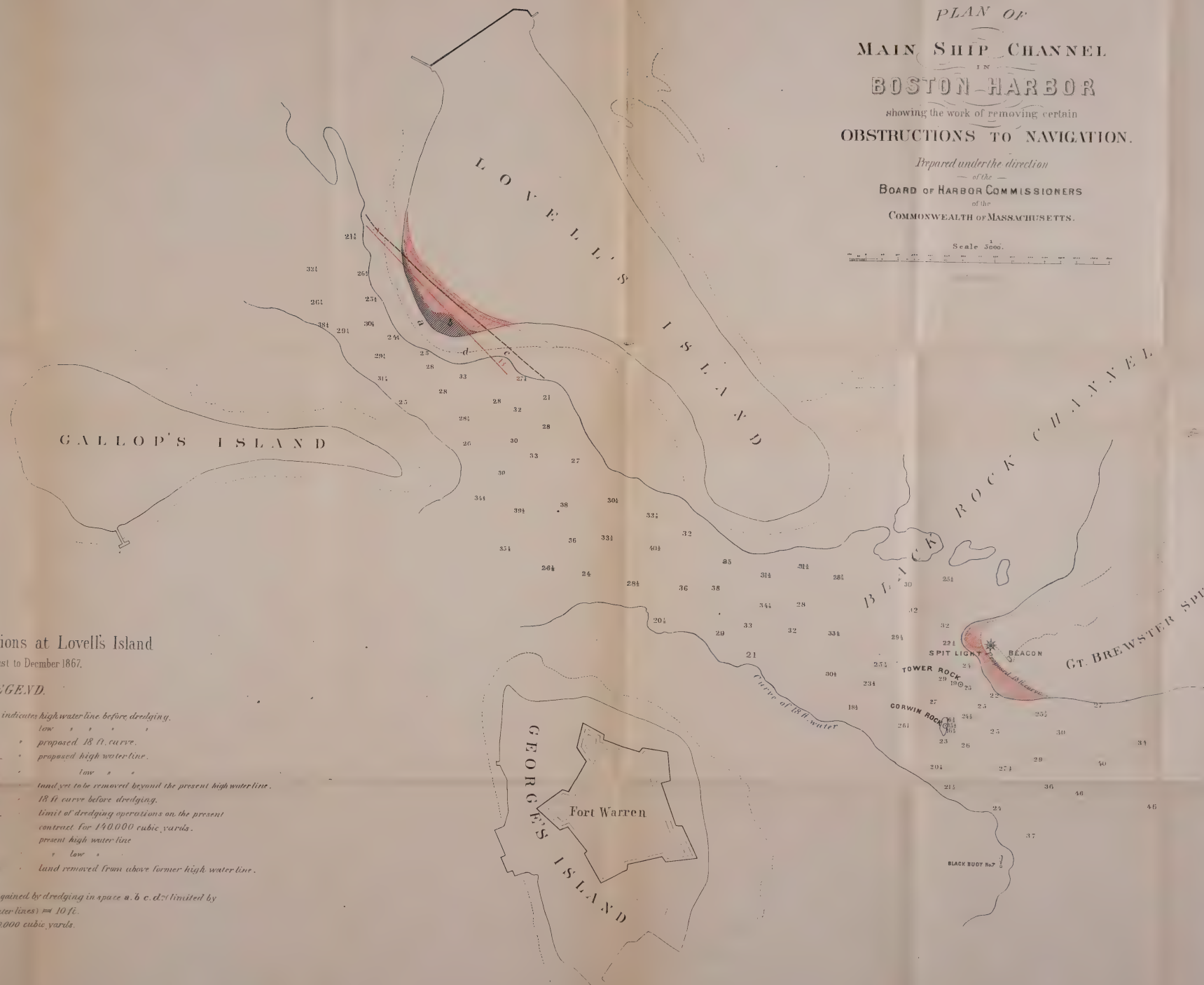
PLAN OF
MAIN SHIP CHANNEL
IN
BOSTON HARBOR
showing the work of removing certain
OBSTRUCTIONS TO NAVIGATION.

Prepared under the direction
of the
BOARD OF HARBOR COMMISSIONERS
of the
COMMONWEALTH OF MASSACHUSETTS.

Scale 5000.



PINKY MATE SHOAL



Dredging Operations at Lovell's Island
from August to December 1867.

LEGEND.

- | | |
|---------------------------|---|
| Black full line | indicates high water-line before dredging. |
| broken | low |
| Red full line | proposed 18 ft. curve. |
| broken | proposed high water-line. |
| shaded part | land yet to be removed beyond the present high water-line. |
| Blue full line | 18 ft. curve before dredging. |
| Red colored full line A-B | limit of dredging operations on the present contract for 140,000 cubic yards. |
| Red line marked thus | present high water-line |
| dotted line | low |
| and blue shaded part | land removed from above former high water-line. |

NOTE. Average depth at low water gained by dredging in space a. b. c. d. (limited by former and present low water-lines) = 10 ft.
Amount removed, about 60,000 cubic yards.

Nº 1.
CHANGES IN THE BED
OF
BOSTON HARBOR

FROM A COMPARISON OF THE SURVEYS OF

1835 & 1847

Expressed in Cubic Yards

Communicated to the

BOARD OF HARBOR COMMISSIONERS

by the

U. S. ADVISORY COUNCIL

SCALE $\frac{1}{10,000}$

Shoaling 516' 857'

Deepening 348' 516'

*Note. In this diagram deepening is represented by figures in blue ink shoaling by those in black.
 The eighteen feet contour is drawn in to define the limits of the Main Channel.*



CHANGES IN THE BED OF BOSTON HARBOR

FROM A COMPARISON OF THE SURVEYS OF

1847 & 1861

Expressed in Cubic Yards

Communicated to the

BOARD OF HARBOR COMMISSIONERS

by the

U. S. ADVISORY COUNCIL

SCALE 10,000

Shading
Deepening1 205' 608'
805' 146'

Note. In this diagram deepening is represented by figures in blue ink. Shading by those in black.
The lighter red contour is drawn in to depict the limits of the Moon Channel.





No III.
CHANGES IN THE BED
OF
BOSTON HARBOR
 FROM A COMPARISON OF THE SURVEYS OF
 1835 & 1861
 Expressed in Cubic Yards
 Communicated to the
 BOARD OF HARBOR COMMISSIONERS
 by the
 U. S. ADVISORY COUNCIL

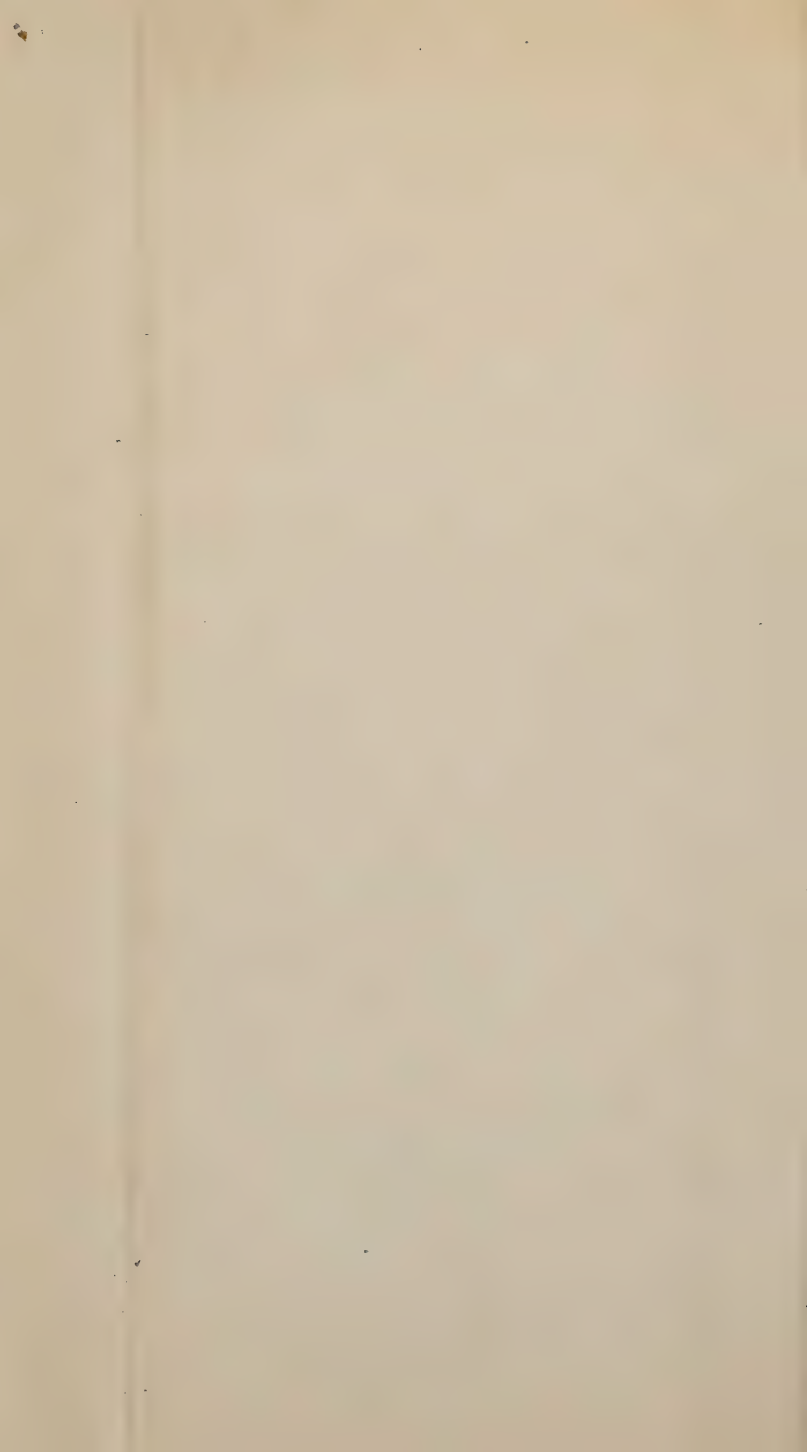
SCALE 1 to 3333

Charles River Basin above Crayles Bridge	Shoaling 308' 290	Deepening 5' 220	383' 980
Mouth of Charles River below Crayles Bridge	2' 220	263' 940	361' 250
Mouth of Mystic River between Meridian & Bridges	8' 840	255' 920	426' 140
Navy Yard & Battery Wharf	74' 740	164' 260	89' 210
Battery Wharf Anchorage Shoal	520' 180	116' 520	373' 660

Note. In this diagram deepening is represented by figures in blue ink, shoaling by those in black.
 The reference for contour is drawn in to define the limits of the Main Channel.

A. H. Wood, Junr.





THIRD ANNUAL REPORT

OF THE

Board of Harbor Commissioners.

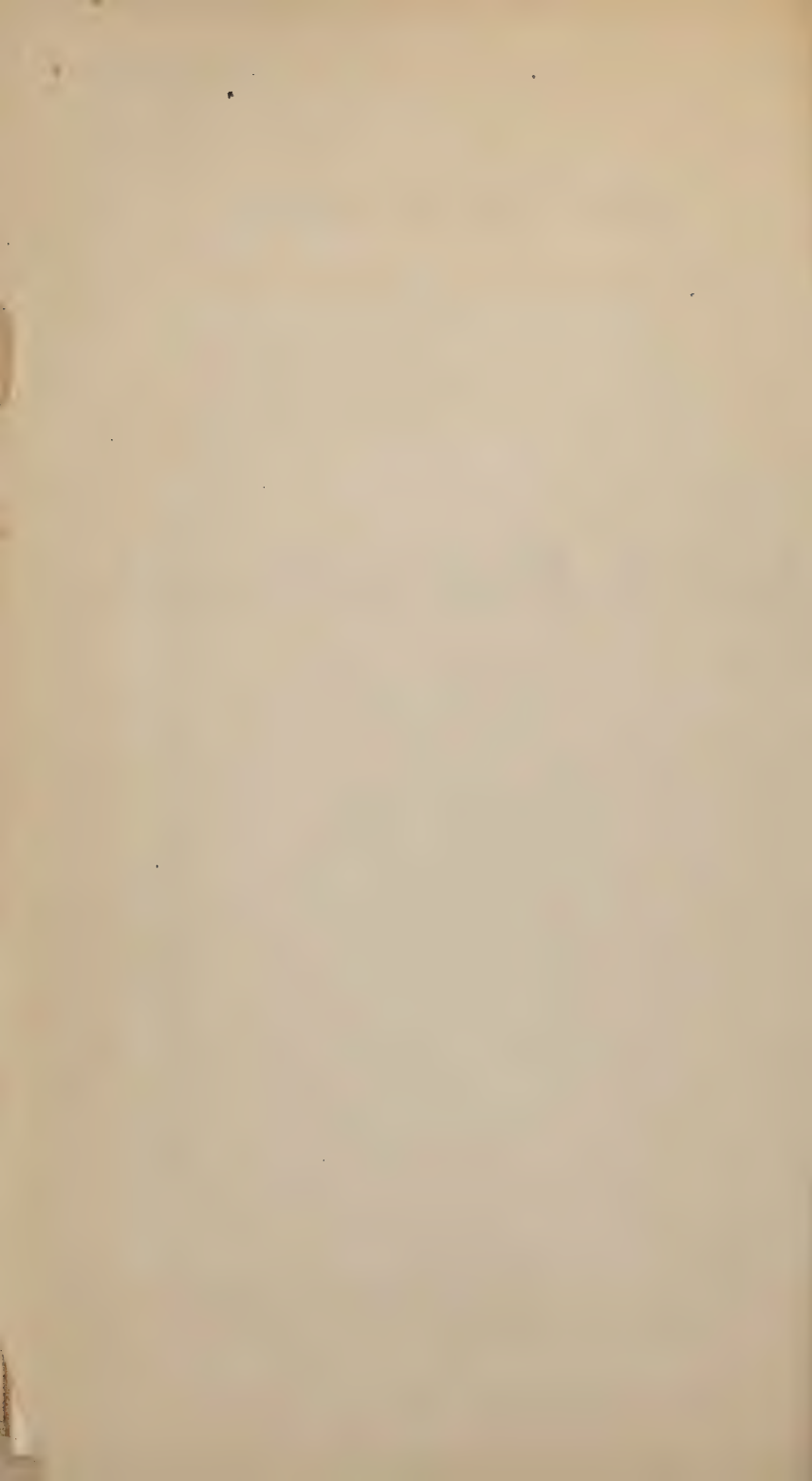
JANUARY, 1869.

BOSTON:

WRIGHT & POTTER, STATE PRINTERS,

79 MILK STREET, (CORNER OF FEDERAL.)

1869.



Commonwealth of Massachusetts.

REPORT.

*To the Honorable the Senate and the House of Representatives
of the Commonwealth of Massachusetts.*

In accordance with the provisions of section 8, chapter 149 of the Acts of the year 1866, the Board of Harbor Commissioners beg leave to submit their Third Annual Report.

PLAN FOR THE OCCUPATION OF SOUTH BOSTON FLATS.

The existing plan for the improvement of the South Boston Flats in its main features was developed by the United States Commissioners on Boston Harbor, representing in Professor Bache, the Superintendent of the Coast Survey, Gen. Totten, and after his decease, Gen. Delafield, Chief Engineers of the United States Army, Rear-Admiral Davis, of the United States Navy Observatory, and Mr. Henry Mitchell, Consulting Engineer to the Commission, scientific and engineering ability of the highest character in the country. A series of annual reports made to the city of Boston, gave the elaborate investigations and studies of Boston Harbor, out of which the plan for the occupation of the South Boston flats was matured. Their investigations led them to recommend, from a purely physical point of view, and as benefit to the tidal system of the harbor, the construction on the easterly line of Fort Point Channel and the south-westerly margin of the main channel, of a sea-wall of solid masonry to prevent the dispersion of tide-water over the flats, and by its concentration in the main channel along the wall, counteract a tendency to shoaling that now exists there.

The attention of these Commissioners having then been called

to the question of the occupation of these flats for business, and the importance of making them available for such purposes, they made investigations to ascertain the conditions upon which this could be done with safety. The displacement from the upper harbor of the immense volume of tide-water which at every tide floods the hundreds of acres of these flats and helps to keep the harbor channels open, and the reduction of scouring force that must be the necessary result of such displacement, were insuperable objections in their minds to the scheme of occupation, unless compensation for such displacement could be secured by making available elsewhere for scour, an equally effective volume of tide-water.

Upon this necessity of compensating for any tide-water displaced in the upper harbor of Boston, we quote their emphatic and imperative language. "The filling up of a portion of the harbor near the mouth, in this particular case, would, perhaps, be locally of no measurable injury, and would deprive the main avenue leading to the sea of so little scouring power that no sensible effect would ever follow; but higher up towards the head of the harbor the same displacement would deprive the entire avenue below it of an element of scouring power which it cannot everywhere or as a whole afford to lose. The upper harbor of Boston, because of the local value of its main channel, and because of the indirect value of its tidal volume to adjacent portions of the lower harbor channels, *cannot, in our opinion, afford to lose another cubic yard of tide-water.* If the application of the compensation rule involves expenses exceeding the benefits to be derived in the most desirable project of occupation, still, we repeat, the harbor cannot afford the loss of tide-water. We do not doubt that the business facilities of your city may be improved by the occupation of flats at various points, but can you or your successors afford to see the smallest additional injury inflicted upon the channel, which some of your clipper ships cannot now traverse till helped over its bars by the rise of the tide, and then only with the aid of a fair wind or a steam-tug? You ask us to advise you in the conservation of your harbor, and we recommend as a matter of primary importance to this end, that you solicit of the legislature the passage of a law *prohibiting any further displacement of the upper harbor tide-water without compensation.*"

The system of compensation devised by the United States Commissioners as inseparable from any plan of occupation, provided that the volume of water displaced from the flats of South Boston should be transferred to Charles River, Mystic River and Chelsea Creek, by extensive excavations between high and low water mark in those tidal reservoirs. In 1866, by chapter 149 of the Acts of that year, the Commonwealth adopted these recommendations of the United States Commissioners, by passing a law establishing the Board of Harbor Commissioners, and requiring compensation for all tide-water displaced by structures built under subsequent grants of the legislature, in the upper harbor of Boston. By chapter 81 of the Resolves of the same year, the Commonwealth adopted the plan for the occupation of the South Boston flats, made in accordance with the views of the United States Commissioners and presented to the legislature of 1866 in the report of the State Commissioners on harbors and flats; a copy of this plan with the modifications of the same since authorized and made, is annexed to this Report. The execution of it requires the construction of a sea-wall on the easterly side of Fort Point Channel and along the margin of the main channel to Castle Island, the extension of the wharves on the westerly side of Fort Point Channel at the mouth on the lines laid down, and the filling solid of all the flats inclosed by the sea-wall, except what shall be reserved for docks opening out upon the main channel, and for a channel-way, so long as it is deemed advisable, on the line of riparian ownership, to give convenient access to the land of the shore owners. The same legislature that established this Board and enacted the law which it was to administer, instructed it to report to the following legislature the probable cost of the filling and the building of the wall, wharves, streets, and sewers required by the plan; "also the probable expense of making compensation for tidal water to be shut out by the filling of said flats; also to ascertain and report on what terms and conditions the said walls, wharves, streets, sewers, or any part thereof can be built by any corporations or individuals, and on what terms and conditions the said flats or any part thereof can be filled, and on what terms and conditions the said flats or any parcels thereof can be sold to any corporations or individuals, either for money or for filling other portions of said flats, and in what

places and manner compensation for the tide-water shut out by filling said flats can best be made, and on what terms and conditions persons whose lands are to be affected by said compensation will give authority to make the same * * * *, the said commissioners in all plans and proposals submitted by them always regarding the protection and improvement of the harbor of Boston as of paramount importance in any intended occupation of said flats * * * *; provided that compensation for all tide-water excluded by carrying into effect these resolves shall be duly made as provided in the act to establish a Board of Harbor Commissioners * *; provided that no money shall be paid from the treasury of the Commonwealth; provided also that nothing shall be done under this resolve which shall conflict with the plan of the South Boston flats accompanying the report of the Commissioners on harbors and flats of the Commonwealth of Massachusetts, presented to the legislature on the sixth day of January in the year 1866, or which shall conflict with the reports of the United States Commissioners."

The Board reported in accordance with these instructions, to the legislature of 1867. No offer to purchase the flats could be obtained. The only terms of a contract for carrying out the proposed improvement, which the Board was able to obtain, were those arranged with the city of Boston, though not finally agreed to, and these terms were communicated to the legislature. Under them the whole territory, comprising some 750 acres, was to be conveyed to the city of Boston, on condition that the city should carry out the improvement on the plan adopted by the Commonwealth, make the requisite compensation for displaced tide-water, by excavations on Chelsea Creek, Charles and Mystic Rivers, pay into the State treasury one hundred thousand dollars, and ten per cent. of the net profits of the improvement, for the benefit of all the harbors throughout the State, except that of Boston, and hold the remaining ninety per cent. of the profits and the income of the same, as a fund to be applied for the benefit of the harbor of Boston. The estimated cost of dredging and excavations for compensation alone for the first two sections, as recommended by the U. S. Commissioners, amounted to nearly two million dollars.

The legislature of 1867, however, preferred that the Com-

monwealth should retain the control in the execution of this improvement, and accordingly authorized this Board, subject to executive approval, to contract for the construction of a "continuous" sea-wall as far as Slate Ledge, noted on the annexed plan, upon a location to be fixed by an engineer to be appointed by the Governor. This was the least extent of wall which, in the opinion of the United States Commissioners, could be built without injury to the harbor. Two hundred thousand dollars were appropriated for its construction. The same legislature also appointed a committee of nine of its members, with full powers to carry out the proposed improvement by any contracts payable in land or flats, which should not take money from the treasury of the Commonwealth; and in relation to compensation, provided "that said committee shall neither fill nor make any contract for the filling of any portion of said flats, nor allow the same to be filled by any person or persons without first providing for such compensation for tide-water displaced as may be necessary for the protection and preservation of the harbor of Boston," &c. In consequence of the inadequacy of the appropriation for the construction of a "continuous" sea-wall, according to the specifications of the State engineer, and heavy enough for the location finally fixed by him, no contract was made by the Board. The legislative committee in the course of their investigations, came to the conclusion that the legislation then existing did not furnish a satisfactory basis for the prosecution of the work, and they too made no contracts.

Although no wall was built or filling done in the year 1867, much was accomplished by way of developing a plan of operations for the execution of this improvement. Impressed with the magnitude of the incumbrance upon the scheme for the occupation of the South Boston flats, imposed by the obligation to compensate for displaced tide-water by enlarging tidal reservoirs of the harbor according to the plan of the United States Commissioners, which was adopted by the legislature of 1866, and which by the legislation of that year the Harbor Commissioners were enjoined to adhere to, the Board determined soon after the adjournment of the legislature of 1867, to make a new investigation for the purpose of ascertaining whether this method of making compensation was the best and most economical that could be devised, and whether some other solution of this prob-

lem of compensation could not be worked out. This investigation was conducted by the United States Advisory Council, and the result was to relieve this great undertaking of the principal obstacle that stood in the way. The United States Commission had declared that as a preliminary step to the excavations to be made in Mystic and Charles Rivers, an improvement of the outlets would be indispensable. The encroachment of wharves and bridges on the mouths of these rivers had already made them insufficient for the free course of the water flowing through them. The obstruction of these outlets, and the increased velocity induced by this reduction of the outlets, had caused the mud and sand to be swept by the current in large masses from their beds, and carried into the harbor. To make these avenues sufficiently large for an increased flow of tide-water, without further disturbance of the beds, either the wharves and bridges must have been in part removed, or artificial excavations must have been made in anticipation of the new regimen to be induced by the introduction of the compensating volume of tide-water. Either mode of *preparing* for the adoption of a system of compensation in kind would involve a large expenditure of money to be added to the expense of compensation itself. It was estimated that "the expense of a proper transfer of the tide-water from South Boston flats to interior basins would exceed the cost of removing all the bars and shoals from the main channel, and the further cost of maintaining the channel in its improved condition forever." The Board, therefore, in their report to the legislature of 1868, recommended that, instead of expending vast sums upon these reservoirs and their outlets, and waiting many years for improvements to develop themselves in the harbor below, the expenditure should be made directly upon the main channel, especially as every shovelful of earth taken from the bed of the channel would be available for filling upon the flats. They made, therefore, the following proposition: "As soon as the wall has sufficiently advanced to offer proper protection to the filling, dredging shall commence in the main channel, and the material be used for reclamation, until the flats in front of the wall are wholly removed to the depth of twenty-three feet at mean low water, and the anchorage shoal also excavated to the same depth; and furthermore, from the profits arising from

the sale of reclaimed flats the sum of \$500,000 shall be funded and the interest used in repairing the damages which may arise from the reduced tidal volume and in maintaining the depth generally of the main channel." On the plan annexed to this Report, the space in the main ship channel colored red indicates the shoal ground to be removed; and if to this is added the amount of material in the upper middle, which the United States government has provided for removing from the space designated on the same plan, and which will be available for filling also, a total of 3,233,000 cubic yards is obtained, sufficient to fill to grade 13, or 3 feet above mean high water, about 6,380,000 square feet of flats.

This scheme does not violate the principle of compensation insisted upon by the United States Commissioners. It merely secures the object of compensation by other means. The object of compensation is the maintenance of the scour. Under this plan, the scouring force is the dredging machine instead of the current of water. The United States Advisory Council accepted this plan of compensation in the following opinion communicated to this Board:—

"We are satisfied that your proposition to use in the reclamation of the 'first section' of South Boston Flats, material dredged from the borders of the main channel to the extent that may be required for the removal of the anchorage shoal and the flats lying beyond the 'quay line' of the United States commission to the depth of twenty-three feet at mean low-water, and to the total amount of 3,233,000 cubic yards, may be accepted as adequate 'compensation,' *provided*, that from the profits of this reclamation, a fund shall be reserved which shall be sufficient to yield an annual interest of not less than \$25,000, to be expended by your Board in maintaining the depth gained in the main channel, and in preserving the present depths elsewhere in this channel.

"A. A. HUMPHREYS,

"Brig. & Bret. Maj. Gen. U. S. A. Chief of Engineers.

"BENJAMIN PEIRCE,

"Superintendent U. S. Coast Survey.

"HENRY MITCHELL,

"Assistant U. S. Coast Survey.

"UNITED STATES ADVISORY COUNCIL to Board of Harbor Commissioners of Massachusetts."

The excavation in this manner of the anchorage shoal and the flats in front of the wall, and the use for filling section 1 of the material so obtained give, at the same time, an addition to Boston of over two hundred acres of land available for railroads, manufactures and commerce, and to Boston Harbor, some two hundred acres of deep anchorage ground. The execution of the whole improvement by taking the material from the bottom of the harbor and using it for filling, will give an addition of some five hundred acres of deep-water anchorage to the harbor of Boston. Upon this satisfactory basis, as regards compensation and material for filling, the legislature of 1868, by chapter 326 of the Acts of that year, placed the prosecution of this work. The Board of Harbor Commissioners was authorized by that Act, subject in all things to the approval of the governor and council, to contract for the sea-wall and the execution of the whole or any part of the work of improvement and make any bargains in relation to this territory that would not take money out of the treasury of the Commonwealth, beyond the unexpended balance of the appropriation made in 1867 for the sea-wall. The legislature did not provide for the formation of a fund from the proceeds of this undertaking to remedy any shoaling or other injuries that may result from the great displacement of tide-water involved in this work, but it gave what is equivalent to a fund, the pledge of the Commonwealth that, "if it shall appear from hydrographical and physical surveys that injury to the harbor has resulted from the work herein authorized, then such injury shall be repaired by dredging or otherwise in such manner and to such extent as the legislature shall hereafter determine."

We have given this sketch of the legislation upon the subject of this improvement, to facilitate investigation of its history since the establishment of this Board, and to show the principles that have been steadily maintained by successive legislatures in their dealing with the work. The experience of the last year, has shown that the existing basis of legislation is sufficient to secure the execution of as much of the work as can be done in the course of three or four years, to yield a profit to the Commonwealth sufficient to defray all expenditures, to remedy all injurious consequences to the harbor that may result from the work, and leave a balance in the treasury.

Whether greater risks shall be incurred by the Commonwealth in the hope of putting more money into the treasury, is a question which it is for the legislature to decide, and upon which it is hardly within our province to advise.

CONTRACTS CONCERNING SOUTH BOSTON FLATS.

Immediately after the passage of the Act of 1868, chapter 326, giving to the board authority to contract in the name of the Commonwealth with any person or persons, or with the city of Boston, for the filling of any portion of the lands or flats in Boston Harbor which lie northerly of South Boston and easterly of Fort Point Channel, and within the exterior line laid down on the plan for the occupation of the flats owned by the Commonwealth in Boston Harbor, approved by the legislature in the eighty-first chapter of the Resolves of the year eighteen hundred and sixty-six, and for building wharves, docks, sea-walls, basins, streets, bridges or sewers, and for dredging or doing any work upon or in relation to said flats, and to pay for the same by conveyances of any portion of said flats, or the granting of any rights or privileges therein, advertisements were made for proposals for filling the first section and building a sea-wall, and negotiations entered into which resulted in four contracts, which were laid before the governor and council on the 14th day of August. The character of and the reasons for presenting these contracts were stated in communications to Governor Bullock.

The first contract was with the Boston Wharf Company. By chapter 450 of the Acts of the year 1855 a license was given to the company by the legislature, to occupy about forty acres of flats, in such a position on Fort Point Channel as to deprive the State of convenient access to its own property beyond. As nothing had been done under this license, the legislature of 1867, by section 4 of chapter 354 of the Acts of that year, repealed it; and the legal question as to the constitutionality of the repeal is pending before the supreme court. By this contract, a compromise was made by which the Boston Wharf Company were to release to the State, in consideration of a perfect title to the balance, in flats and rights of wharfage, what the Board considered equal or equivalent to about one-half of the disputed territory. The division of the flats, as proposed, is shown on the annexed plan.

The second contract was for the construction of a wall of about 700 feet in length on Fort Point Channel. As this was to be set back twenty-seven feet from the channel and protected, whenever used, by a platform, one built upon piles, (similar to that of the Boston Wharf, which has stood for many years,) and costing only \$33 a running foot, was deemed to be sufficient. This wall, as well as the next, was awarded to the Rockport Granite Company and Messrs. Clapp & Ballou, and is similar to the one agreed to be built by the Boston Wharf Company on this territory under their contract.

The third contract was for a sea-wall on the main channel. The Act of the legislature provides that, as a method of compensation, portions of the harbor shall be dredged to the depth of twenty-three feet at low water. The foundation of the wall must therefore be laid at that depth, and be of strength sufficient to stand against storms on one side and the pressure of material on the other. As any imperfection in this work might lead to most serious results, by precipitating a vast amount of material into the harbor, to its great injury, the Commission asked the advice of Major-General J. G. Foster, George R. Baldwin, James B. Francis and T. Willis Pratt, four engineers of the highest character and greatest experience in structures of this nature. The Board submitted seven different plans for a wall, and asked them to recommend the cheapest structure that in their opinion would be sufficient for the purpose. After several consultations they unanimously recommended the plan that was submitted to the governor and council. On the eleventh day of July the Commissioners advertised for proposals for construction of a wall on this plan, which were opened on the third day of August. They received four bids: two for \$17.50, one for \$12.00 and one (which was accepted) at \$11.40 a yard laid, which would amount to \$189 a running foot. As the wall had to be laid by means of submarine divers at the depth of 23 feet at low water of dimension stones without pinners, this was thought to be as good an offer as any responsible bidders could be expected to make. In addition to this, the Commissioners undertook that the contractor for filling the flats should excavate to the depth of 23 feet at low water and prepare, a level bed for the reception of the masonry.

Such a wall could not be built except at a great expense;

the resources at the command of the Commissioners were \$193,000, the balance of an appropriation made in the year 1867 of \$200,000, and the right to pay for the same in land or flats. The Commissioners felt certain from the bids received that with the cash appropriation they could build the 700 feet of wall of the first contract and nine hundred and five feet of that provided for in the second, and that the balance could be paid for in flats or filled land, without calling on the legislature for any further appropriation.

Having thus provided for the exterior wall, the Commissioners advertised for proposals for filling any portion of the flats inclosed, the contractor to be paid by receiving either flats unfilled or a portion of those that were embraced in his contract; this being the mode of payment provided by the legislature.

But one bid was received in response to the advertisement, and this was made by N. C. Munson, well known as the contractor for filling the Back Bay lands, and many other important works,—a man believed to be perfectly able to carry out any contract he might undertake. He offered within three years to fill, with material dredged from the bottom of the harbor, at such points as the Commissioners should direct, and with a surface covering of three feet of clean gravel, 4,660,870 (four million six hundred and sixty thousand eight hundred and seventy) square feet, which, at the lowest probable rate, would amount to an outlay of \$2,000,000, of which a large part must be expended before any return, either for principal or interest, could be made. From time to time, as fast as filled to the proper grade, he proposed that the Commonwealth should deed to him the land to the west of B Street extended, amounting to 3,460,870 square feet, and retain 1,200,000 feet to the east of the same street. The amount demanded was large and embraced that part of the property that would first come into the market; but as it was the only bid, the Commissioners had contracts carefully drawn and submitted them to the governor and council.

By this contract, Mr. Munson agreed that the Board might at any time *alter or cancel* the contract, and his damages were to be assessed by the governor and council without appeal. The Commonwealth could, it was believed, under this contract, protect itself against any improper or unreasonable use of the territory to be acquired by the contractor.

The Board would have been happy if other competitors had enabled them to make a better bargain for the Commonwealth; but having an opportunity of making a contract that would insure the immediate commencement and final completion of a work that would benefit, incalculably, the harbor of her capital, and add millions to the taxable property of the State, they were unwilling to take the responsibility of risking the whole on the contingency of their being able to make another bargain with the Boston Wharf Company, or getting another contract on better terms, especially as these contracts related to less than a seventh of the seven hundred and fifty acres in this locality belonging to the Commonwealth.

The several contracts were referred to a committee of the honorable council who reported on them as follows: "A contract with the Boston Wharf Company, by which it is proposed to compromise the conflicting claims of title to certain flats between the Wharf Company and the Commonwealth, by a partition of the territory in dispute, and a conveyance from each party to the other of certain specified portions thereof, with further provisions as to sea-wall and filling—this contract, the committee believe to have been wisely made, and that a settlement thus early to be accomplished will prove beneficial to both parties. But we are advised by the Harbor Commissioners that the contract is, in certain particulars, so connected with, and dependent upon, the other proposed contracts, that unless they shall be approved, some modifications will be necessary to make this contract practicable. In view, therefore, of the conclusion to which we have arrived with reference to the others, we recommend the return of this contract to the Harbor Commissioners for further negotiation with the company.

"There are two contracts with the Rockport Granite Company and Messrs. Clapp & Ballou for building sea-walls; one upon Fort Point Channel and the other upon or near the exterior line of the harbor as recommended by the United States Commissioners. These contracts appear to have been well made, the work required substantial, and the prices to be paid reasonable. These, also, in a measure depend upon the Munson contract hereinafter named, and cannot be approved unless that is approved.

“A contract with Mr. N. C. Munson, which provides for filling 4,665,000 square feet or more than one hundred acres, of flats, extending from Fort Point Channel and lands of the Boston Wharf Company on the west to a line about seven hundred feet easterly from B Street extended, and substantially parallel therewith. For filling this territory the contractor is to take for his compensation all the land lying between said channel and land of the Wharf Company on the west, to the line of B Street extended, amounting to 3,465,000 square feet, or, in round numbers, seventy-nine and a half acres. And the Commonwealth, as its share in the contract, a strip of filled land, about 700 feet wide on the easterly side of B Street extended, containing 1,200,000 square feet, or about twenty-seven acres.”

After an able discussion of the probable value of the land which would be conveyed to Mr. Munson “a majority of the committee were of opinion that these contracts should be disallowed, in the hope that the Harbor Commissioners will yet be able to present others, more advantageous to the Commonwealth.”

This report was accepted and the contracts disallowed and returned to the Commissioners on the 30th day of November.

The Commissioners advertised again for proposals for the filling or purchase of the flats, returnable on the 19th day of December, but without success, no bid whatever having been made.

Since the last advertisement they have been informed that some of the railroads have appointed committees to consider the subject of obtaining freight accommodation on these flats, and the Commissioners hope by negotiation with the various parties to submit a new contract for filling which will obviate the objections made to the former.

STRUCTURES OVER TIDE-WATERS.

By authority of section 4, chapter 149 of the Acts of the year 1866, which provides that all persons who have been or may be authorized by the legislature to build over tide-waters any bridge, wharf, pier or dam, or to fill any flats, or to drive any piles below high-water mark, who have not already begun such work, shall, before beginning it, give notice in writing to the

Harbor Commissioners of the work they intend to do, and no such work shall be commenced until the plan and mode of performing the same shall be approved in writing by a majority of the board,—the Commissioners have carefully examined and approved plans for the following structures :

The extension of a pile wharf in the harbor of Gloucester by Parker Burnham and Elias Burnham, under the authority of chapter 190 of the Acts of the year 1867.—*Approved January 9.*

The extension of a pile wharf in the harbor of Gloucester, by Alfred Low and Company, under the authority of chapter 190 of the Acts of the year 1867.—*Approved January 9.*

The construction of a solid wharf and a pile wharf in the harbor of Gloucester, by George H. Rogers, under the authority of chapter 190 of the Acts of the year 1867.—*Approved January 9.*

The construction of a pile wharf on the easterly side of the East Chop of Holmes' Hole Harbor, under the authority of chapter 37 of the Acts of the year 1866.—*Approved February 21.*

The construction of three pile wharves in the harbor of Chilmark, under the authority of chapter 196 of the Acts of the year 1867.—*Approved March 19.*

The extension of a wharf in the harbor of Hingham, by Harvey T. Litchfield, under the authority of chapter 262 of the Acts of the year 1867.—*Approved March 19.*

The location and plan for construction of connecting tracks by the Eastern and Fitchburg Railroad Corporations near their present intersection in the city of Charlestown, under the authority of chapter 335 of the Acts of the year 1867,—compensation to be made for tide-water displaced by solid filling or pile structures.—*Approved July 31.*

The extension of a solid wharf and pile wharf in the harbor of Gloucester, by the Gloucester Gas Light Company, under the authority of chapter 190 of the Acts of the year 1867.—*Approved August 6.*

The extension of a pile wharf in the harbor of Gloucester, by Andrew W. Dodd, under the authority of chapter 190 of the Acts of the year 1867.—*Approved August 6.*

The extension of a pile wharf in the harbor of Gloucester,

by Sylvanus Smith and Addison Gott, Jr., under the authority of chapter 190 of the Acts of the year 1867.—*Approved October 22.*

The extension of a pile wharf in the harbor of Gloucester, by Robert Tarr, 2d, and James Tarr, Jr., under the authority of chapter 190 of the Acts of the year 1867.—*Approved October 22.*

The extension of a pile wharf in the harbor of Gloucester, by William Parsons, 2d, under the authority of chapter 190 of the Acts of the year 1867.—*Approved November 23.*

The extension of a pile wharf in the harbor of Gloucester, by Wm. C. Wonson, under the authority of chapter 190 of the Acts of the year 1867.—*Approved November 23.*

Considerable difficulty was experienced in establishing the boundaries of the two last named structures so as to harmonize the interests of the riparian proprietors on Coo's Cove. The Board instructed their engineer to prepare a plan for the extension of the wharves in this cove, in such manner that the riparian owners in said cove, except James Davis, whose land was too narrow for the construction of a wharf, could have equal proportionate rights of advancing with wharves towards said harbor line, and that provision should be made for convenient access to such wharves and the land of said Davis and other riparian owners, by docks of proper width and length, and make report to the Board. His plan was adopted. The method pursued by him in making this plan, we consider of so much importance and applicable to so many cases, that we annex his report in the Appendix.

It will be observed that the Board have assumed that they have the right under the statute of determining that waterspaces for docks shall be reserved between the extended wharves, although such reservations are not expressly provided for in the statute. Each shore owner has by the Act, the right of extending his wharf over any flats of the Commonwealth, that may lie between his outer lines and the harbor lines there now established, but in such manner that all persons affected by this grant may have equal proportionate rights of advancing to or toward the said harbor lines. We have assumed the right to provide docks, for the reason that unless there were docks reserved on these flats, there could not be wharves; the flats would be wholly covered over, while an occupation by *wharves* only is

what the statute authorizes. There is, however, still a question when the wharf is built and the dock reserved, what rights of wharfage or dockage the statute gives to the proprietor of the wharf, on the reserved water-space. None are given expressly by the statute, and we doubt whether any are given by implication. Beyond the limits of the wharf, the owner, it would seem, has no rights beyond those which he has in common with all other persons in open navigable waters. The proper use of wharf property requires, however, that rights of wharfage and dockage should be appurtenant to the right to maintain a wharf. We would recommend, therefore, legislation that shall define the rights of the owner of a wharf built under the provisions of this statute, to wharfage and dockage as appurtenant to his wharf.

EAST BOSTON BRIDGE.

In March last, the Commissioners deemed it their duty to call the attention of the Secretary of the Navy to the proposition then before the legislature to build a bridge to East Boston from the city proper. A plan of the harbor in front of the Navy Yard, showing the proposed location of the bridge, was forwarded to the Secretary; and after examining the subject he replied on the 13th of April, that "the construction of such a bridge would be a most calamitous act, so far as the navy was concerned, as it would be a great injury to the several government establishments lying above that locality—the Navy Yard, Navy Hospital, Magazine, and Shell-house, and the Nitre Depot at Malden. Already there are too many bridges and draws above the locality for the proposed bridge, which impede the passage of vessels. The dispatch of a United States vessel from the yard in case of emergency might be stopped for hours, and accidents to them in that thoroughfare would not be improbable. The department would feel compelled to oppose strenuously such a structure." The Board opposed the bridge at the hearings before the harbor committee of the legislature.

The aid of the city council of Boston was asked by the friends of the measure in support of the application for a charter; but the joint committee on the harbor, to whom the subject was referred, reported adversely to the committal of the city in behalf of the proposed structure, and their report was accepted.

On the eleventh of June the legislature passed the Act, over the governor's veto, to incorporate the Maverick Bridge.

As the ultimate authority over the matter is vested in the Congress of the United States, a joint resolution authorizing the Secretary of the Navy to detail three officers as a Commission to examine and report in relation to the erection of a bridge in Boston Harbor, was passed by Congress and approved by the President July 7th. On the first of September, Rear-Admirals S. H. Stringham and C. H. Bell, and Brevet Brigadier-General J. H. Simpson, of the Engineer Corps, were detailed by the Secretary, and commenced their examinations at the Navy Yard in Charlestown, on the 16th of September.

The Commission having applied to this Board for information and assistance in prosecuting their inquiries, Mr. Boschke, the engineer of the Board, prepared under its instructions a careful statement of facts bearing upon the subject and a plan of the location of the proposed bridge. His report and plan were submitted to the Commission, and at its hearings some members of the Board were present.

MISCELLANEOUS.

Certain inhabitants of the town of Ipswich having petitioned the last legislature for an Act to protect the harbor of Ipswich by restraining the removal of sand from "Sandy Point," so called, the subject was referred to this Board, in April last, by the harbor committee of the legislature, with a request to report whether any injury was caused to the harbor by the removal of sand. A hearing was given to the petitioners and remonstrants; and at the conclusion the Board directed their engineer to visit Ipswich and make such surveys of Sandy Point and the bars as he should deem necessary.

The engineer subsequently reported that a comparison of the present state of the entrance to the harbor with surveys made in 1855, indicated a continuous growth of the beach where the sand was taken away by vessels; and that he could not discover any injury resulting from such removal of sand to the harbor or anchorage. The Board subsequently reported to the committee of the legislature that no legislation was necessary.

In May, Mr. Henry Mitchell, a member of our U. S. Advisory Council, to whom the Board had been indebted for much

valuable information, being about to visit Europe on inquiries instituted by the Government Coast Survey relative to the improvement of harbors, was requested to communicate to us any information that he might gather, relative to the organizations, powers and labors of Boards similar to this, together with such other results of his inquiries as he might deem useful; and a circular letter was given by the Board to aid him in his purpose.

On the 6th of August, the Mystic Water Board of Charlestown submitted plans for laying an eight-inch water pipe across Mystic River on the upper side of Malden Bridge, for the purpose of supplying the Charlestown almshouse with water. Under the authority of chapter 212 of the Acts of the year 1866, the plans were approved by this Board.

The city of Charlestown having been authorized by an Act of the last legislature (chapter 253,) to fill up, under the direction of the Harbor Commissioners, the flats known as the "flats in Prison Point Bay," upon making compensation, from time to time, for the amount of tide-water displaced by the filling, the same to be ascertained by the Harbor Commissioners, the mayor of Charlestown made application to the Board, in July last, for information as to the amount which would be required.

In reply, it was stated that the Board would require the city of Charlestown to pay thirty-seven cents for every cubic yard of tide-water displaced in filling flats; or, if the city preferred, compensation might be made by dredging, between high and low-water mark, an amount of material equal in bulk to the tide-water displaced—the dredging to be done under the direction of this Board, at places pointed out by its engineer in the basin between the Boston and Maine and Eastern Railroads, and in the basin between East Cambridge Bridge and Brookline Bridge.

In December the Fitchburg and the Boston and Maine Railroad Corporations petitioned this Board to approve plans which they submitted for widening their bridges over Charles River for the purpose of making proper connections with the Marginal Freight Railway Company. After a full hearing on the subject the Commissioners were of the opinion that the petitioners had received no authority from the legislature to build any struct-

ure over tide-waters in Charles River below low-water mark, and gave them leave to withdraw.

Much time was spent by the Commissioners during the session of the legislature of 1868 in attendance upon the Harbor Committee, agreeably to its request.

We would recommend that the legislature provide that rights in tide-waters in the Upper Harbor of Boston shall be acquired only by an express and never by an implied grant in legislative Acts. The most careful scrutiny of bills before the legislature often fails to detect important encroachments upon the public domain which the face of the measures does not disclose. A legislative rule of construction, such as is proposed, would remedy this evil.

Major-General H. W. Benham and Major-General J. G. Foster, U. S. Engineers in charge of the works that are being carried on in Boston Harbor and Cape Cod Harbor under the authority of the United States, have favored this Board with copies of their respective official reports to Major-General A. A. Humphreys, Chief of Engineers. These reports are hereto appended.

We congratulate the Commonwealth that the works in Boston Harbor, though uncompleted, have already secured for it great and obvious advantages. Among the benefits thus conferred on the harbor, we may mention that the Tower and Corwin Rocks, lying directly in the main ship channel, have been entirely removed, and that this great highway of commerce has also been widened and greatly improved by dredging away the south-west point of Lovell's Island.

It is not for us to speak of the highly successful accomplishment of the important work in Cape Cod Harbor assumed by the Commonwealth, as the Commissioners having it in charge will report upon it. General Foster's report affords interesting information of the work done in that harbor by the United States.

In June last one of the Commissioners visited Washington in order to secure a continuance of the necessary appropriations for Boston Harbor; of the general appropriation by Congress for the prosecution of works in progress, the sum of \$40,000 was devoted by the War Department to the works in Boston Harbor.

This Board has recently addressed a memorial to Congress urging the necessary appropriations to complete the harbor improvements above referred to.

The Harbor Commissioners report with great regret the resignation of Albert Boschke, Esq., who has been their engineer from the first organization of the Board. His great engineering skill and familiarity with the subjects upon which the Commissioners are required to act, his sound judgment on all scientific and practical questions submitted to him, as well as his great zeal and industry in the service, render his withdrawal from the office a great loss to the Commonwealth.

JOSIAH QUINCY,
S. E. SEWALL,
WILLIAM MIXTER,
F. W. LINCOLN, JR.,
DARWIN E. WARE,

Board of Harbor Commissioners.

MEMORANDUM.—Since this Report and the annexed plan were prepared, the Board has received from the Boston Wharf Company the following notice: “that as the governor and council have not ratified the contract made between you and the Boston Wharf Company, dated August 12, 1868, the Boston Wharf Company withdraws from said agreement and requests that the papers may be returned for cancellation.”

EAST BOSTON

PLAN

for the occupation of

FLATS OWNED BY THE COMMONWEALTH

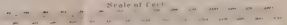
BOSTON HARBOR

APPROVED AND ADOPTED BY THE GENERAL COURT

AND MODIFIED ACCORDING TO CHAP. 354 OF THE ACTS OF 1867
and Chapter 354 of the Acts of 1867

SCALE 1:1000

Scale of Feet



BIRD ISLAND

GOVERNOR'S ISLAND

CASTLE IS.

SHIP CHANNEL

SECTION I.

SECTION II.

SECTION III.

Channel of 500 feet wide

SIX INSTITUTIONS
FIRST
SECOND
THIRD

BOSTON

SOUTH BAY

SOUTH BOSTON

PONT

WATER

WATER

WATER

WATER

APPENDIX.

HARBOR COMMISSIONERS' OFFICE, }
BOSTON, November 23, 1868. }

Hon. JOSIAH QUINCY, *Chairman of Board of Harbor Commissioners.*

SIR:—I have the honor to report the principles upon which, in accordance with the instructions of the Board, I have divided the Commonwealth's flats granted for occupation by wharves to the riparian owners of Coo's Cove in Gloucester Harbor, by chapter 190 of the Acts of the year 1867, and respectfully submit the plan of division for your approval. The rule of the supreme judicial court heretofore applied to the division of flats situated in coves and within the line of riparian ownership is not applicable in this case, since the owners of the two headlands would not receive, what the statute under which rights of occupation are granted would entitle them to, under the provision, that "all persons affected by this grant shall have equal proportional rights of *advancing to or towards* the said harbor lines." This equal proportionate right of advancing, can only be obtained by setting off to each riparian owner an equal proportionate area of the Commonwealth's flats. I endeavored, therefore, to divide the whole area between the low-water line and the harbor commissioners' line into equal proportionate parcels, in proportion to the length upon the low-water line, which the supreme judicial court has decided that each party is entitled to. To accomplish this, I adopted the following method:

If the shore is assumed to be a straight line and the low-water line is parallel thereto, the division lines of the flats between the respective shore owners, would be lines perpendicular to the shore line, and each owner would have with mathematical correctness, by such lines, proportionate rights of advancing from the shore line to the low-water line. As we can assume that a cove of ever so irregular a form, consists of a great number of straight lines of small dimensions, the above rule can be applied to any case and will find its extreme application in the circle.

The practical application of the above rule in this case at Gloucester, I made by drawing lines 20 feet distant from each other,

parallel to the low-water line or limit of riparian ownership and over the whole of the Commonwealth's flats within the harbor commissioners' line, and divided the first of these auxiliary lines in the same proportion as the riparian owners own upon the low-water line; this divides the first belt of 20 feet wide and gives each owner a proportionate right of advance for the first 20 feet. Then I divided the second auxiliary line 40 feet distant from the low-water line, into the same proportional parts as the first auxiliary line,—the line 20 feet from the low-water line; this divided the second belt in equal proportionate parts in the same manner as the first belt; and so on, I made belts and divided them, until I reached the limit of the cove or flats as defined and bounded by the harbor commissioners' line. In connecting all the points of division upon the auxiliary lines, we obtain lines of division between the parties. It is apparent that the lines of division of irregular shores can only be irregular lines, and so not suitable for boundary lines of wharves; a straight line being desirable. It only remained to establish such a straight line by setting off to the one or the other party such equal areas, which the intersection of a straight line with an irregular line would give or take from the one to the other party on each side of the straight line.

This process gives all persons "equal proportionate rights of advancing to or towards the harbor lines," and is applicable in all cases that may hereafter arise.

The instructions of the Board further require that provision shall be made for convenient access to such wharves and the land of Davis and other riparian proprietors, by docks of proper width and length.

By the accompanying plan you will perceive, that I have drawn the limits and direction of the wharves upon the equitable ground, that each owner of the flats, as divided between them in the above described manner, should contribute an equal area towards the formation of suitable docks or slips. In the present instance, this admits of the construction of three large wharves and two commodious docks. The fourth party, Mr. James Davis, will not be able to advance to the harbor lines with his wharf, as he owns only 10 feet upon the low-water line. He will however, have ample access to his premises by the dock between the wharves of Wm. Wonson and Wm. Parsons, 2d.

Most respectfully,

Your obedient servant,

A. BOSCHKE.

IMPROVEMENTS IN BOSTON HARBOR.

GEN. BENHAM'S REPORT.

[COPY.]

BOSTON, MASS., Jan. 11, 1869.

Major-Gen. A. A. HUMPHREYS, *Chief of Engineers.*

General:—I have the honor to make the following Report in relation to works on the sea-walls for the protection of the principal islands in this harbor, during the past season of 1868.

At Deer Island. The walls of the south and middle heads having been rebuilt in 1866-7;—during the last season work was commenced on the north head wall, which is about eighteen hundred feet long. The whole of this work was put under contract, and eight hundred feet of it finished during 1868. The remaining one thousand feet will probably be completed this year, 1869, and, when finished, will entirely protect this island, as far as now appears necessary, and secure it against encroaching on the main ship channel at Deer Island Spit, where the most danger is now apprehended.

At Lovell's Island. A wall ten feet high including foundation, and about eight hundred feet long has been entirely finished, with the necessary jetties for its security at the angles, during the last working season. This wall protects the south-east bluff of the island, and, as soon as the coming season will permit, work will be recommenced on the few repairs needed for the wall at north-west head, originally built in 1843. These repairs being finished, no further protection will probably be needed to this island, and it is hoped it will be secured against any farther encroachments upon or towards the "Narrows" of the main channel.

At Great Brewster Island. The north and south head walls as originally planned, were completed in previous years, with the exception of the earth filling and paving in rear of the north head wall. This filling and paving was nearly completed during the year 1868, and a dry masonry wall about six feet high has been laid in the

gap between the north and south heads, to serve as a temporary protection until an appropriation is available to close this gap, (as is now recommended,) by a wall similar to the others, which I trust will fully guard against the danger now feared, that the island may be cut in two by any unusual violence of the sea, over the lowland between the two heads.

The funds now available will probably complete the north head wall at the rear, as proposed, and when the gap above-mentioned is finally closed, this most exposed island will be fully protected, and it is hoped there will be no farther increment to the Great Brewster Island Spit, near Fort Warren.

From the above it will be seen that these three most important works upon islands situated so near, and, by their abrasion of so much danger to the main ship channels, are already well advanced towards completion, and that another working season will probably suffice for all the operations needed upon them, if the funds now asked for, for the Great Brewster Island, (\$25,000,) shall have been granted by Congress during the present session.

Very respectfully your obedient servant,

(Signed,)

H. W. BENHAM,

Brevet Major-General.

GEN. FOSTER'S REPORTS.

BOSTON, MASS., January 9, 1869.

HON. JOSIAH QUINCY, *Chairman of Board of Harbor Commissioners of the State of Massachusetts, Boston, Mass.*

Dear Sir:—In accordance with your request, I inclose herewith copies of my reports to Brevet Major-Gen. A. A. Humphreys, Chief of Engineers, U. S. A. as follows:—

1st. Report for the fiscal year ending June 30, 1868.

2d. Brief Report of operations for the year ending December 31, 1868.

3d. Special Report on Provincetown Harbor, dated December 21, 1868.

These give all the main points of information relative to the works of harbor improvements carried on by the general government in this State under my charge.

Very respectfully your obedient servant,

J. G. FOSTER, *Brevet Major-Gen. U. S. A.,
Lt.-Col. Engineers.*

[COPY.]

BOSTON, MASS., Sept. 5, 1868.

Brevet Major-Gen. A. A. HUMPHREYS, *Chief of Engineers, II. Q.
Corps of Engineers, Washington, D. C.*

General:—I have the honor to make the following Report of progress in the works of harbor improvement under my charge during the fiscal year ending the 30th of June, 1868.

Preservation and Improvement of Boston Harbor.

As soon as the preliminary surveys were completed, proposals were invited for dredging the south-west point of Lovell's Island, for dredging the channel across the upper middle bar, and for blasting and removing the rocks in the Narrows between the light on the west extremity of Great Brewster Spit and Fort Warren.

The contract for dredging the south-west point of Lovell's Island was awarded to Mr. Albert Boschke, the lowest bidder. Under his contract the work has been prosecuted with vigor, and 92,899 cubic yards of dredged material removed, widening the channel at that

point to 600 feet at the 13 foot curve, and to an average depth of the dredged area of thirteen feet at mean low water. A larger and more powerful dredging machine is now being built by Mr. Boschke intended to carry the depth over this dredged area to twenty-three feet at mean low water, the depth required by contract and by the requirements of navigation. It is also proposed to dredge off a portion of the extreme south point of Lovell's Island and the edge of the shoal on the east side of Gallop's Island, directly opposite Lovell's Island.

Total amount expended during the fiscal year ending	
June 30, 1868,	\$46,258 02
Probable amount to be expended during the fiscal year	
ending June 30, 1869,	\$42,741 98
Amount required to complete the widening of the	
channel at this point to 685 feet and a depth of 23	
feet, the width and depth desired and estimated for	
by the Board of Harbor Commissioners,	\$99,805 00

The contract for dredging the upper middle bar was awarded to Mr. Charles Woolley, one of the two lowest bidders, preference being given to him as he was a resident of Boston and had the necessary dredging machine on the spot to prosecute the work at once. After a brief attempt of a part of one day to perform the work, Mr. Woolley abandoned it, and refused to comply with the terms of his contract in prosecuting it in any manner or even paying the forfeited amount of his sureties. The contract was then given to Mr. Wm. W. Wright, of Geneva, N. Y., the other bidder, who gave the requisite sureties for the performance of the work. As, however, he had previously been notified that the contract had been awarded to Mr. Woolley, he had in the mean time disposed of the dredging machine with which he proposed to do the work, and was unable afterwards to procure a dredging machine in time, and has transferred his contract to Mr. Albert Boschke of this city. The work was not commenced on the 30th of June, 1868.

Amount expended during the fiscal year ending June	
30th, 1868,	\$3,454 11
Probable amount to be expended during the fiscal year	
ending June 30, 1869,	\$35,545 89
Amount required to complete the dredging at this point	
to a depth of 23 feet at mean low water and a width	
of 1,000 feet as estimated for by the Board of Harbor	
Commissioners,	\$118,085 00

Blasting and removing Tower and Corwin Rocks.

The work has been successfully carried on under the direction of Mr. Geo. W. Townsend, contractor, and has resulted in the entire removal of "Tower Rock" to a depth of 23 feet at mean low water, and the entire removal of "Corwin Rock," and the adjacent ledge lying between "Corwin Rock" and Fort Warren, to a general depth of 22 feet at mean low water, and over the larger portion of its surface to 23 feet at mean low water.

Six hundred and fifty tons of rock have been blasted from these rocks, hoisted up, and deposited on shore. Many tons of small fragments that were thrown into deep water by the explosion of the blast were suffered to remain on the bottom, where they in no way interfered with navigation.

The amount available will, it is expected, nearly complete the entire removal of these rocks heretofore so dangerous to navigation.

Amount expended during the fiscal year ending June	
30, 1868,	\$20,842 25
Probable amount to be expended during the fiscal	
year ending June 30, 1869,	9,157 75

Sea - Wall at Point Allerton.

As there were no funds available for the purchase of the site necessary for the construction of this wall, application was made, by the engineer in charge, to the legislature of the Commonwealth of Massachusetts, for the appropriation of the sum necessary to purchase the strip of ground near high water upon which to build the wall, together with the shoals in front and the necessary slope in rear, to be presented in fee simple to the United States. The necessary sum—one hundred and seventy-five dollars—was appropriated at the last session, and is now available.

As soon as the necessary examination of title can be made, the purchase and transfer to the United States will be completed, after which the work may be commenced, as agreements have already been made for the rent of the portion of the adjoining land necessary to be used in the construction of the wall.

Amount expended during the fiscal year ending June	
30, 1868,	\$4,889 52
Probable amount to be expended during the fiscal	
year ending June 30, 1869,	45,110 48
Amount required to complete the work,	20,991 87

Sea - Wall for the Preservation of Gallop's Island.

Upon application of the engineer in charge, the city of Boston, which owns this island, presented to the United States the strip of ground upon which to build this wall, with the shoals in front and slopes in rear, and also gave permission to use the necessary amount of land, temporary buildings, wharf, &c., required in the construction of the wall.

Contracts for the material and work were entered into in the month of May, a cement house was built, the necessary temporary buildings for use of laborers removed to the site, and all preparations completed for the commencement and rapid prosecution of the work.

The contracts for the workmanship and for the granite for this wall were awarded to Mr. James Andrews, of Biddeford, Maine, the contracts for the sand and cement to Messrs. T. W. Hoxie & Co., and for the broken stone for concrete to Mr. Franklin Mead, of Boston.

Amount expended during the fiscal year ending June 30, 1868,	\$5,647 16
Probable amount to be expended during the fiscal year ending June 30, 1869,	44,352 84
Amount required to be appropriated for the fiscal year ending June 30, 1870, to complete the work,	53,585 63

Sea - Wall for the Preservation of the North Head of Long Island.

The negotiations for the purchase of the north head of this island, with the lowland adjacent, for military purposes, having failed to obtain a favorable result, the officer having it in charge, Brevet Major-General H. W. Benham, was ordered to co-operate with Brevet Major-General J. G. Foster, in the effort to obtain from the legislature of the Commonwealth the passage of a law providing for the acquisition of the titles to the necessary land by the United States.

Application was accordingly made, and was successful in obtaining the passage of a law providing for the determination of the price to be paid by the United States, by means of the jury of the superior court of the county, and the vesting of the titles in fee simple in the United States, upon the deposit of the sum so determined in the hands of the judge of the court. Application will be

made to the court at its next session, and as soon as the titles are thus secured the sea-wall may be commenced.

Experiments upon various kinds of materials for pavements in rear of the coping of sea-walls were carried on during the winter, and reported upon in a special report.

Amount expended during the fiscal year ending June	
30, 1868,	\$7,674 54
Probable amount to be expended during the fiscal	
year ending June 30, 1869,	67,325 46
Amount required to be appropriated for the fiscal	
year ending June 30, 1870, to complete the work,	75,00 00

Preservation of Provincetown Harbor, Cape Cod, Mass.

Under the charge of Colonel H. W. Benham, Brevet Major-General U. S. A., until June 22, 1868, since then of Lieutenant-Colonel J. G. Foster, Brevet Major-General U. S. A.

At Long Point, the aproning of stone near the light-house has been extended to the eastward during the summer. Several hundred tons of stone have thus been deposited with favorable result, as they maintain their position and afford an efficient protection to the beach.

At Beach Point, preparations are being made to repair the injuries done to that narrow strip of beach by a storm in April of this year. Plans of a brush bulkhead and jetties for this purpose, and for the protection of the beach towards the inlet to East Harbor, have been prepared, and advertisements inviting proposals for the construction of the same will shortly be published.

As fears are entertained by many of the inhabitants that the encroachments of the sea upon the outer or sea beach may result, during some great storm, in the formation of a breach through the sand-ridge into East Harbor, preparations are being made by the present engineer in charge for the construction of a dike across the salt meadows and East Harbor Creek, at a place called the "wading place," opposite "High Head."

The observations for determining the tides and currents and the nature and extent of the changes in Provincetown Harbor, under the immediate direction of Captain George Burroughs, Brevet Major U. S. A., will be carried on diligently by that officer, under the appropriation for "*Examinations and Surveys on the Atlantic Coast.*"

Amount expended from appropriation for preservation of Provincetown Harbor for the fiscal year ending June 30, 1868,	\$6,542 42
Probable amount to be expended during the fiscal year ending June 30, 1869,	36,751 26
Amount required to be appropriated for the fiscal year ending June 30, 1870, to complete the work,	20,000 00

It is difficult to estimate the expense necessary for the permanent completion of the works for the preservation of Provincetown Harbor, as they necessarily change with every new cause of injury and the effect of violent storms.

I have also the honor to report upon the points called for in Engineer Circular of June 15, 1868, as follows, viz. :—

1st. The plan adopted for the works of preservation and improvement of Boston Harbor is substantially that of the Harbor Commissioners of the Commonwealth of Massachusetts, which have met the general approval of the Chief of Engineers.

The items of this plan are as follows, viz. :—

For dredging a channel across the Upper Middle Bar 1,000 feet in width and to a depth of 23 feet at mean low-water, at a total estimated cost of \$157,085 00

For dredging off the S. W. point of Lovell's Island and the extremity of Great Brewster Spit so as to widen the channel to 685 feet at the 18 feet curve, and to carry the dredging to the depth of 23 feet at mean low-water mark, at a total estimated cost of 188,805 00

For the removal by blasting of "Tower Rock" and "Corwin Rock" to a depth of 23 feet at mean low-water, at a total estimated cost of 20,000 00

For the construction of a sea-wall around the north head of Long Island, at an estimated cost of 150,000 00

For the construction of a sea-wall around the north end of Gallop's Island, at an estimated cost of 103,585 00

For the construction of a sea-wall around the extremity of Point Allerton, at an estimated cost of, . . 70,991 87

Total for the preservation and improvement of
Boston Harbor, \$690,467 50

The result of re-survey and actual work of removal have shown that the cost of removing "Tower" and "Corwin" Rocks by blasting to the required depth will exceed the sum of \$30,000.00.

Also that the western extremity of the Great Brewster Spit has ceased to extend itself into the channel, and that the removal of "Tower" and "Corwin" Rocks will render unnecessary the dredging off the extremity of the Spit.

Also that the cut at the south-west point of Lovell's Island should be extended, at the depth of 23 feet, entirely along that side of the island parallel to the axis of the channel, and that a similar and parallel cut should be made on the opposite side of the channel from the shoal on the north-east side of Gallop's Island.

2d. The amounts that are required for the entire and permanent completion of each work of preservation and improvement under my charge are given in the previous paragraph No. 1, with the exception of the removal of Tower and Corwin Rocks, which will cost \$35,000.00.

3d. The amount that can profitably be expended upon each work during the fiscal year is as follows, viz.:—

In Boston Harbor.

For the sea-wall at the north head of Long Island, .	\$75,000 00
" " " Gallop's Island,	34,000 00
" " " Point Allerton,	21,000 00
For dredging the south-west point and south-west side of Lovell Island and the north-east side of Gallop's Island,	99,805 00
For dredging the Upper Middle Bar,	118,085 00
For blasting and removing Corwin Rock,	15,000 00

In Provincetown Harbor, Cape Cod.

For the protection of the beach of Long Point, .	\$10,000 00
" " " Beach Point,	20,000 00
" construction of the dyke at the wading place, .	8,000 00

4th. The works in Boston Harbor are in the collection district of Boston and Charlestown, Massachusetts.

5th. The works in Boston Harbor are in the port of Boston, Massachusetts. Those at the Narrows are near Fort Warren, those at the Upper Middle Bar are near Fort Independence, those at Point Allerton near Boston Light-House, and those on Long Island near Long Island Light-House.

The works of preservation in Provincetown Harbor, Cape Cod, are located: those at Long Point near Long Point Light-House,

and those at Beach Point and in the salt meadows are about equally distant from the latter Light-House and Cape Cod Light-House.

6th. The amount of revenue collected at the port of Boston during the fiscal year ending June 30, 1868, as communicated to me by the collector of the port of Boston, Judge Thomas Russell, is \$15,974,581.34.

The amount collected at the port of Provincetown, as communicated to me by the officer of customs, Mr. Isaiah Gifford at Provincetown, is \$5,324.61.

The collector of the port of Boston informs me that the amount of commerce and navigation that will be benefited by the works of improvement in this harbor will be as follows, viz:—

Whole number of vessels that enter and leave by the channel through the Narrows annually, 24,000.

Amount of tonnage during the fiscal year ending June 30, 1868, was as follows, viz:—

Tonnage entered from foreign ports,	731,930
“ “ “ domestic ports,	956,133
“ cleared for foreign ports,	689,822
“ “ “ domestic ports,	1,243,366
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Total tonnage entered and cleared at Boston,	3,621,251

The amount of commerce to be benefited by the proposed improvement it is difficult to estimate, as no approximation can be made of the amount of the coasting trade; the imports and exports however are accessible, and amounted during the last fiscal year to the following:—

Total imports,	\$37,039,771 00
“ exports,	17,348,423 00
<hr/>	
Aggregate amount of foreign commerce,	\$54,388,094 00

* * * * *

I have the honor to be, very respectfully, your obedient servant,

J. G. FOSTER,

Bvt. Maj.-Gen. U. S. A., Lt. Col. Eng'rs.

[COPY.]

BOSTON, MASS., December 21st, 1868.

Bvt. Maj.-Gen'l A. A. HUMPHREYS, *Chief of Engineers, Headquarters Corps of Engineers, Washington, D. C.*

General,—Since the date of my annual report I have been able, by repeated inspections, to make more definite estimates of the amount required to be appropriated, at this session of Congress, for the protection and improvement of Provincetown Harbor, Cape Cod.

These will increase the amount required as estimated by me in my annual report, to \$30,000.00.

The several items of expenditure are as follows, viz.:—

For the extension of the bulkhead built for the preservation of the north end of Beach Point, along the embankment of the State Dyke to the north shore of the Inlet, (now closed,) being 700 running feet at \$6.00,	\$4,200 00
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For extending the brush bulkhead and jetties over the site of the plank jetties and bulkhead built by General Benham, being 1,200 running feet of bulkhead and 1,200 running feet of jetties 2,400 feet, at \$6.00,	14,400 00
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For completing the stone protection of Long Point from the Light House to the position of the large wooden jetties built by General Benham across the cove opposite the battery at the Light House, 1,200 tons, at \$3.00,	3,600 00
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For building a catch-sand, of brush and strips of board, across the marsh south-west of Provincetown, from Stevens' Point to House Point Island, and thence to the nearest point of Long Point, being 6,000 running feet at \$1.00,	6,000 00
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For constructing a brush bulkhead across the inner channel near Abel Hill, to prevent the flow of the high tide through from Lancy's Harbor to the inner harbor of Provincetown, being 600 feet at \$6.00,	3,600 00
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For planting beach grass upon the sand hills north of East Harbor and the salt meadow,	5,000 00
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\$36,800 00

Deduct the amount on hand after paying for the dyke at the "Wading Place,"	6,800 00
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Amount required to be appropriated,	\$30,000 00
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I would respectfully request that the above amount may be asked for, in view of the importance of this harbor, and of the efficient protection that the above works will give it.

I remain, General, very respectfully, your obedient servant,

(Signed,)

J. G. FOSTER,

Bvt. Maj.-Gen'l U. S. A., Lt. Col. Eng'rs.

[COPY.]

CITY HALL, BOSTON, MASS., Jan. 9, 1869.

Brevet Major-Gen. A. A. HUMPHREYS, *Chief of Engineers, Headquarters Corps of Engineers, Washington, D. C.*

General,—I have the honor to furnish, in accordance with your direction, the following brief statement of the progress of the works of improvement under my charge in this harbor during the year ending December 31, 1868.

At the south-west point of Lovell's Island the dredging has been continued by the contractor, Mr. Boschke, until the available appropriation became exhausted. About 92,000 cubic yards have been dredged and removed to the dumping ground.

The width of the channel between the 18 foot curve on the Gallop's Island side and the 13 foot curve upon the Lovell's Island side has been increased from 365 feet, its original width, to 625 feet, thus making a gain in width of 260 feet. This widening has already caused an increase in the current and volume of the ebb tide, which will prevent any further accumulation of debris at this point after being once removed.

The dredging was only carried to the depth of 18 feet at low water, as that was the effective working limit of the dredge in use. A new and more powerful machine has been constructed, and now is in this harbor, by means of which, as soon as the appropriation asked for becomes available, the depth over the whole dredged area will be carried to 23 feet at mean low water.

It is expected that this new machine will leave the bottom after dredging of an uniform level, and thus obviate the difficulty experienced in using dredges with buckets at the end of long arms, which are apt to allow the bucket to slide around rocks or hard lumps, and thus to leave ridges in the dredged surface. The new dredge, acting by a surface plough and continuous chain-buckets

which are held firmly to their line of work, is calculated especially to remedy this defect of the old dredges.

It is also proposed to dredge off a portion of the extreme southern point of Lovell's Island where it encroaches upon the channel, and also to remove the edge of the shoal on the east side of Gallop's Island, directly opposite Lovell's Island.

The amount asked for to complete these improvements is \$99,805.00.

The Upper Middle Bar.

The dredging of the centre of the channel at this point will be commenced at once, as the large dredge, built expressly for this work and for the dredging at the Narrows, is already in this harbor.

The sum available is sufficient to excavate a channel through this bar, 120 feet wide, to the depth of 23 feet at mean low water. A further appropriation has been asked for to complete the widening to 1,000 feet, as estimated for by the Board of Harbor Commissioners, of \$118,085.00.

Sea - Wall for the Preservation of Gallop's Island.

Upon application of the engineer in charge the city of Boston gave to the United States the strip of ground upon which to build this wall, and also the use of the temporary buildings for the occupancy of the workmen. Contracts for the work were entered into, the work commenced, and 350 feet of excellent sea-wall constructed during the season. The work will be continued next season to the limit of the present appropriation, and completed as funds become available from future appropriations.

Sea - Wall for the Preservation of North Head of Long Island.

The title to the site of this work not having as yet been secured, the work has not been commenced.

Sea - Wall for the Preservation of Point Allerton.

The legislature of the Commonwealth having appropriated the necessary amount to purchase the site for this wall for presentation to the United States, the purchase has been completed and the titles forwarded to the engineer department for approval.

As soon as this is received proposals will be advertised for and contracts made for the prosecution of the work in the coming season.

Blasting and Removing Tower and Corwin Rocks.

This work has been successfully carried on and completed by the contractor, Mr. George W. Townsend.

These two dangerous rocks, lying in the channel between Fort Warren and Great Brewster Spit Light, and *directly* in the channel, have been entirely removed to the depth of 23 feet at mean low water.

This work has been accomplished by submarine divers and by the use of a steam submarine drilling machine of ingenious and simple construction, invented for and used for the first time upon this rock. With its use the rocks have been drilled and blasted as though they were upon the surface. The fragments have then been hoisted on board of the working vessel, — the pieces being slung or packed in tubs by the divers, — and the whole deposited on shore.

Only the small fragments, too small to be of harm, were suffered to remain on the bottom around the rocks, where they had been blown by the blasts.

About 1,200 tons of stone have thus been taken off these rocks and deposited on shore.

The complete success achieved in the removal of Tower and Corwin rocks has directed attention to two other dangerous rocks in the entrances to this harbor, and requests have been made for their complete survey with a view to making estimates for their final removal.

These are "Barrel Rock" and "Kelley's Rock." The first of these lies $1\frac{1}{4}$ miles east of Deer Island, directly in Broad Sound Channel, and, having only 4 feet of water upon it at low water, constitutes a dangerous obstruction to navigation, especially in foggy weather, which shuts out objects on shore from which bearings might be taken, and also conceals the buoy which marks the position of this rock until vessels are too near to avoid it. The second rock lies in the main ship channel between the Great Brewster Spit Light and Boston Light, about half a mile from the former, and has 17 feet of water upon it at low tide. It is in a very dangerous position, from the fact that vessels have to change their course opposite it, while if it were removed they could make a nearly straight course from Boston Light until opposite the Great Brewster Spit Light, which course would take them farther from the "centurian rocks," and of course much relieve them of the danger of running upon them in thick weather.

It was my intention to have made a thorough survey of both these rocks by submarine divers, but the work upon Corwin Rock was of longer duration than anticipated, so that its completion was not reached until December, when the lateness of the season and rough weather prevented the survey.

From careful inquiries of pilots and others, I am enabled to make the following estimate:—

For blasting and removing Barrel Rock, . . .	\$5,000 00
For blasting and removing Kelley's Rock, . . .	20,000 00

I respectfully request that these two items may be added in my annual report, and if it meets your approval, that the necessary appropriation may be asked for.

I have the honor to be, very respectfully,

Your obedient servant,

(Signed,)

J. G. FOSTER,

Brevet Major-Gen. U. S. A., Lt. Col. Engineers.

FOURTH ANNUAL REPORT

OF THE

Board of Harbor Commissioners.

JANUARY, 1870.

BOSTON:

WRIGHT & POTTER, STATE PRINTERS,
79 MILK STREET (CORNER OF FEDERAL).

1870.

Commonwealth of Massachusetts.

R E P O R T .

*To the Honorable the Senate and the House of Representatives
of the Commonwealth of Massachusetts.*

The Board of Harbor Commissioners respectfully submit
their Fourth Annual Report.

SOUTH BOSTON FLATS.

That portion of our last report which related to the improvement of the Commonwealth's flats in South Boston, concluded with an account of four contracts that had been made by the Board in the year 1868, and submitted to the governor and council for approval. Two of these contracts were with the Rockport Granite Company for the construction, at the expense of the State, of two walls of different character upon the outer line of the flats along Fort Point Channel and the main channel of Boston Harbor. Another contract was with Mr. N. C. Munson, for the filling of so much of the flats as lay west of the westerly line of B Street extended and within the line of the proposed sea-walls, to grade 13, with material dredged from the harbor, and to a grade of three feet additional upon the surface with gravel, and for such a division of the land filled, as a consideration for the filling, as would give Mr. Munson 3,465,000 square feet, and 1,200,000 square feet to the Commonwealth. The other contract was with the Boston Wharf Company, and was a compromise of a question of title to the area of flats that lies between the Commissioners' lines A

and B on the plan annexed to this report, and extending twelve hundred and fifty feet back from the Commissioners' line on the easterly side of Fort Point Channel. By chapter 455 of the Acts of the year 1855, this company had received authority to extend its wharf, in the manner allowed by law, over this area of flats. Nothing, however, having been done under this authority for more than ten years, it was revoked by the legislature of 1867. The Boston Wharf Company contested the constitutionality of this revocation, and suits were pending for the trial of this question. The importance of this compromise was due to the fact that it was an essential part of the scheme for the occupation of the Commonwealth's flats in this locality, that a sea-wall should be built along the easterly side of Fort Point Channel, and such a wall could not be built without the consent of this company until this question of title had been determined in favor of the State. It was in the power of this corporation or any persons holding its claim, to postpone indefinitely the improvement which the Commonwealth desired at once to enter upon. By the proposed compromise the wharf company released to the State two strips on the north-easterly and south-easterly sides of the tract in dispute, included within the black lines shown upon the plan, amounting to about one-third of the whole area. It released also to the State the rights of wharfage and dockage, which it held on the south-easterly line of its property, and which were not covered by the legislative revocation, but would have seriously interfered with the plans of the Commonwealth in regard to its own flats. The State released to the company the residue of the tract and authorized its occupation by solid filling, the company agreeing to build the requisite wall along Fort Point Channel.

The contracts for the walls, and the compromise with the Boston Wharf Company, met the executive approbation, but the contract for filling not being considered sufficiently favorable to the Commonwealth, failed to receive the approval of a majority of the council. As all the contracts, however, were dependent upon each other, the rejection of one involved the failure of all; and accordingly, on the 21st of November, 1868, all were rejected and returned to this Board. In a memorandum added after the conclusion of our last report, we communicated to the legislature the following notice from the Boston

Wharf Company :—"That as the governor and council have not ratified the contract made between you and the Boston Wharf Company, dated August 12th, 1868, the Boston Wharf Company withdraws from said agreement, and requests that the papers may be returned for cancellation." We were not aware when we communicated this notice to the legislature, nor did we or the public learn the fact until some weeks after, that the Boston Wharf Company had, on the 20th of November, 1868, even before the rejection by the executive council of the contracts submitted by the Board, sold out to the Boston, Hartford and Erie Railroad Company, or rather to the trustees of that company, all its rights in the territory that was the subject of the compromise we have described, in addition to a large area of flats and wharf property, the title to which was unquestioned.

The Boston Wharf Company sold to the trustees of the Boston, Hartford and Erie Railroad Company 2,600,000 square feet of made land and flats, including the area between Commissioners' lines A and B, claimed by the Commonwealth, for \$1,350,000, of which \$1,200,000 was payable in the bonds of the company, secured by a mortgage on the territory conveyed. To complete this transaction according to its terms, it became necessary to ask the authority of the legislature to issue these bonds, and accordingly, a bill was introduced for this purpose into the house of representatives and referred to its committee on the judiciary. The railroad company had bought of the Boston Wharf Company flats which the Commonwealth claimed to own, and now asked the Commonwealth to legalize the transaction. The Board opposed, before the committee, the legislation sought, and any measure that should sanction the bargain with the Boston Wharf Company, on the grounds that it would operate as a surrender on the part of the Commonwealth of its claim to a large tract of the flats covered by that bargain; that the railroad company ought to make the same compromise with the Commonwealth as the Boston Wharf Company, to whose rights it had succeeded; and, furthermore, that if the railroad company bought South Boston flats, it should become a customer for the Commonwealth's flats, and so, in this respect, justify the expectations it raised when it received its first loan from the State in 1867.

The measure finally adopted authorized the issue of these bonds, with the consent of the governor and council, and that consent was given upon the performance of conditions that met all these objections.

SALE OF FLATS TO TRUSTEES OF THE BOSTON, HARTFORD AND ERIE RAILROAD COMPANY.

It was with much apprehension that the Board learned that the claim of the Boston Wharf Company to the flats in dispute had been transferred to a new party. It was feared that this party might insist upon more onerous and perhaps impossible terms as a condition to its consent to the satisfactory compromise that had already been effected, and its indispensable coöperation in the Commonwealth's cherished scheme of improvement. Fortunately, however, for the early inauguration of this enterprise, the Boston, Hartford and Erie Railroad Company needed the coöperation of the Commonwealth in its own undertakings. Moreover, to purchase from the State and occupy an additional area of flats in South Boston would be to continue in the same line, the policy which prompted the purchase of the Boston Wharf Company which had just been concluded. The railroad company desired modifications of the terms of the State aid furnished under chapter 284 of the Acts of the year 1867, and an additional loan of the State scrip. An adjustment between the Commonwealth and the railroad company which should meet the wants of both parties, could only be effected by legislative action. The powers conferred by law upon this Commission were too limited to meet the case. Accordingly, the negotiations for such an adjustment were conducted at the State house rather than at the office of this Board. Before the adjournment of the legislature, an Act was passed (chap. 450, 1869,) changing the terms upon which the scrip of the State was to be advanced to the Boston, Hartford and Erie Railroad Company, and increasing the loan to five million dollars, one million of which, it was provided, should be expended in improving flats which the railroad company was obliged by the act to purchase of the Commonwealth, in order to entitle it to any further issue of the scrip of the State. An understanding between the Board, the governor and council and the company, as to what flats the company should purchase, and how it should improve them, had

been substantially reached before the passage of this act. It was agreed that the railroad company should carry out the compromise that had been made with the Boston Wharf Company; that it should purchase the flats lying between those to be released to the railroad company under the compromise, and the outer limit of the proposed occupation, at the rate of fifty cents a square foot; that it should enclose its flats on Fort Point Channel and the main channel with walls, and fill the area so enclosed in accordance with the contracts submitted to the governor and council by this Board in the previous year. It was not, however, until the 21st of July last, that contracts for carrying out this understanding were perfected in all their manifold details, executed by the Board and approved by the governor and council. The transaction between the Boston Wharf Company and the Boston, Hartford and Erie Railroad Company, to which we have already referred, was the basis of the contracts with the Commonwealth. That had been substantially completed in the month of November previous, in all respects, except the issue of the bonds which had been stipulated for, and only lacked legislative sanction. The conveyance of the Boston Wharf Company, instead of being made directly to the Boston, Hartford and Erie Railroad Company, was made to Peter Harvey, James S. Whitney and Henry B. Groves, trustees of the railroad company, in order that there might be no question that the property acquired by that conveyance was not covered by what is known as the Berdell mortgage. The property conveyed by the Boston Wharf Company is represented by so much of the space colored green on the annexed plan as lies south-west of Commissioners' line B, together with so much of the space colored yellow as lies west of the line M I.

This was mortgaged back by Messrs. Harvey, Whitney, and Groves, trustees, and the Boston, Hartford and Erie Railroad Company to Messrs. Pierce, Atkins and Morton, trustees of the Boston Wharf Company, to secure the payment of the railroad company's bonds to the amount of \$1,200,000, which were to be delivered to and held by the last named trustees under their trust, as soon as the issue of such bonds was authorized by law. A prior mortgage, however, was also executed by the trustees, Messrs. Harvey, Whitney and Groves, to the Boston Wharf Company, upon so much of the property conveyed by

this company as lies south-west of the Commissioners' line A, to secure the payment of a note of \$150,000, which, however, it is agreed shall be surrendered, provided the Boston, Hartford and Erie Railroad Company shall, in six years, construct Eastern Avenue over Fort Point Channel and the mortgaged premises.

As the area of flats in litigation between the Boston Wharf Company and the Commonwealth had been conveyed by the company to trustees of the Boston, Hartford and Erie Railroad Company, and mortgaged back to another set of trustees, the compromise of this disputed title could only be effected by releases, to which both sets of trustees, their *cestuis que trust* and the Commonwealth were parties. And, in this form, by an indenture of five parts, the compromise has been executed. The other four parties released to the Commonwealth so much of the space colored green as lies between Commissioners' line B and the line X Z, so much of the space colored yellow as lies west of the line M I, all rights of wharfage on the southeasterly line of the property acquired of the Boston Wharf Company, all right, if any existed, to have the flats lying beyond that line or beyond any of their land or flats to B Street extended, kept open to tide-water, and all rights in any flats outside the limits of occupation, as defined upon the annexed plan; the residue of the flats in dispute were released by the Commonwealth to the trustees of the railroad company. The Commonwealth then conveyed to Messrs. Harvey, Whitney and Groves, trustees, so much of the area represented upon the plan by the space colored green, as lies north-easterly of the line X Z, amounting to 1,091,010 square feet, excluding Northern Avenue, for the note of the Boston Hartford and Erie Railroad Company for \$545,505, payable in twenty years from July 1, 1869, with interest after three years, at the rate of six per cent. per annum. The deed provides that the territory conveyed shall be surveyed after it is filled, and the price increased or reduced according to the result of that measurement, and reserves to the Commonwealth the right to regulate the drainage of this territory, and to lay out over it Northern Avenue, seventy-five feet in width, substantially as shown upon the plan, and devote it to the uses of a public street, without

any compensation either for the flats on which it is located, or the filling of it to the required grade.

The next step in the transaction was an agreement between the Boston, Hartford and Erie Railroad Company with the Commonwealth for the filling of all the flats of the company lying in front of its solid wharf, and represented on the plan by the space colored green, lying north-easterly of Commissioners' line A, and for the enclosure of these flats on the lines of the channels with suitable sea-walls. By this agreement the filling is to be made to grade thirteen with material dredged from the trenches for the walls, from Fort Point Channel, from that part of Boston Harbor designated on the plan by the space colored red, and from other portions of the upper harbor, according to the authority that shall be given hereafter ; to a grade of three more feet at the surface, the filling is to be made with gravel, amounting in all to grade sixteen determined by the coping of the dry dock of the United States at the Navy Yard, in Charlestown, which is about fifteen feet above mean low water. The walls are to be of two kinds ; one, a light wall suited to the shallower and calmer waters of Fort Point Channel, and the other a heavy wall, capable of standing in an exposed situation on the outer line of the flats along the main channel, where the water will be twenty-three feet deep at mean low tide. The two styles of wall are represented on the plan. The light wall is to be built on a line twenty-five feet inside the Commissioners' line on the easterly side of Fort Point Channel, but is not to be used until the intervening space is occupied by a platform, such as is shown on the plan in connection with the wall. It is of the same construction as the adjoining wall in the Boston Wharf, which had stood the test of use ten years, satisfactorily. The heavy wall is to be laid by the aid of sub-marine divers upon hard bottom, at least twenty-three feet below mean low water ; and to give room for a fender pile outside of the wall, it is to be laid one foot inside of the line of title. The plan of this wall was made by a board of eminent engineers, consisting of T. Willis Pratt, George Baldwin, Gen. J. G. Foster and James B. Francis, who were associated by the Harbor Commissioners in consultation with Mr. Albert Boshke, then their own engineer, in order that the structure decided upon should not want the highest attainable guarantee of strength

and stability. Authority is also given for the construction of a platform outside this wall, extending not more than fourteen feet from the top, a distance which is one foot more than the batter of the wall, and keeps the whole structure within the boundary line of title as conveyed by the Commonwealth.

The Boston, Hartford and Erie Railroad Company, and its trustees, then mortgaged to the Commonwealth all the area of land and flats represented on the plan by the space colored green, as security for the performance of the agreement for the filling and the construction of the wall; for the payment of the note of \$545,505, and of any additional sum that should be found due for the flats purchased upon a measurement of them when filled; for the payment in gold of all the scrip the Commonwealth had advanced or should advance, under the provisions of chapter 284 of the Acts of the year 1867, and of chapter 450 of the Acts of the year 1869, and interest on such scrip in gold as the same should fall due; for the performance of all the obligations of an agreement on the part of said company with the Commonwealth, dated July 10, 1869, provided for in the third section of the last mentioned act, and for the general indemnification of the Commonwealth against all costs, damage, and expense on account of the issue of its scrip to the company. The mortgage gives the Commonwealth a power of sale in the usual form, to be executed upon a default continuing for six months, and written notice of the default given by the governor of the Commonwealth to the mortgagors in trust for the railway company, and the Commonwealth has the right to purchase the mortgaged property at the sale. For so much of this property as lies south-westerly of Commissioners' line A, this mortgage is subject to the two mortgages to the trustees of the Boston Wharf Company, one for \$1,200,000, payable in the bonds of the Boston, Hartford and Erie Railroad Company, and the other for the note for \$150,000 already mentioned. For so much as lies south-westerly of the line X Z on the annexed plan, the mortgage to the Commonwealth is subject to this mortgage for \$1,200,000 alone. The residue of the property lying north-easterly of the line X Z is unincumbered.

As the mortgages to the trustees of the Boston Wharf Company were provided with powers of sale, it became necessary to obtain some guarantee from these trustees that no sale

should take place until the Commonwealth should have an opportunity to save its security under its own mortgage by obtaining, through the action of the legislature, the means of redeeming the prior mortgages. The trustees, accordingly, agreed not to sell until the expiration of nine months after written notice of a default, to the governor of the Commonwealth.

The documents which represent the transaction of which we have now given the main features, are to be found in the Appendix to this Report, in the order of the following enumeration: 1. Deed of the Boston Wharf Company to Harvey and others, trustees. 2. Mortgage of Harvey and others, trustees, to the Boston Wharf Company. 3. Agreement between the Boston Wharf Company and the Boston, Hartford and Erie Railroad Company. 4. Mortgage of Harvey and others, trustees, to Pierce and others, trustees. 5. Agreement between the Commonwealth and the Boston Wharf Company and its trustees and the Boston, Hartford and Erie Railroad and its trustees. 6. Deed of the Commonwealth to Harvey and others, trustees. 7. Agreement of Boston, Hartford and Erie Railroad Company with the Commonwealth. 8. Mortgage of Harvey and others, trustees, to the Commonwealth. 9. Declaration of trust by Harvey and others to the Boston, Hartford, and Erie Railroad Company. 10. Agreement of Pierce and others, trustees, with the Commonwealth. 11. Agreement of Boston, Hartford and Erie Railroad Company with the Boston Wharf Company. 12. Agreement of Boston, Hartford, and Erie Railroad Company with the Commonwealth.

Since the execution of the contract with the Boston, Hartford and Erie Railroad Company, the engineer of the Board has determined the lines for the walls, and their location has been permanently marked by piles. The company has constructed a bulkhead on the south-easterly line of its flats, for the protection of the filling and partially excavated the trenches, for the foundation of its walls. Of the 160,000 cubic yards of filling which the company was required by its contract to have done by the beginning of this year, but about 30,000 cubic yards have been actually put in. The contract, however, provides that during the first year, less than the stipulated amount of filling per month may be done with the consent of the Board and the governor and council, and on the 8th of January, an appli-

cation was made to the Board by the company, for the benefit of this provision, but has not been acted upon.

CONTRACT WITH THE BOSTON AND ALBANY RAILROAD COMPANY.

Negotiations were also had at the State house during the session of the legislature of last year, for the sale of a tract of South Boston flats, to the Boston and Albany Railroad Company. It was arranged that this company should purchase and improve, with a view to connecting its road with deep water at South Boston, at least fifty acres of flats adjoining those to be purchased by the Boston, Hartford and Erie Railroad Company, and that the Commonwealth should sell to it that amount of flats, or more if it would buy them, at twenty cents a square foot, the company to build the sea-wall on the line of the flats purchased, bordering on the main channel. The legislature then passed the act entitled "An Act authorizing the extension of the Boston and Albany Railroad Company to deep water at South Boston, and for other purposes," (chap. 461, 1869,) by the sixth section of which, the railroad company "are authorized to increase their capital stock, by issuing in addition to the amount now allowed by law to be issued, an amount not exceeding five millions of dollars, provided such stock shall not be issued at less than its par value as actually paid in cash," but are not allowed to exercise this privilege until "after the purchase by said Boston and Albany Railroad Company from the Commonwealth, of an amount of flats in South Boston, of not less than fifty acres." The railroad company was not disposed to purchase upon the terms arranged, more than the fifty acres required by the statute. The details of this contract were not entered upon by the Board and the Executive, until after the completion of the transaction with the Boston, Hartford and Erie Railroad Company. It was not, therefore, until the eighth day of December last, that the agreement between the Commonwealth and the Boston and Albany Railroad Company, added in the Appendix, was executed by the Harbor Commissioners and the company, and approved by the governor and council. By its terms, the Commonwealth agrees to sell, and the company to buy, the parcel of flats represented on the plan by the space colored yellow, amounting to fifty acres, exclusive of the areas covered by the extensions to be made over this tract of Northern and East-

ern Avenues and B Street, areas which the Commonwealth reserves the right to lay out as highways, substantially as shown on the annexed plan, without any compensation for the flats, or the filling of them to the required grade. The company is to pay the price, \$545,000, in three years from the first day of July, 1869, either in cash or its bonds, payable in twenty years, with an annual interest of six per cent., but is not to receive the title to the flats, until they have been filled, and a sea-wall has been erected on the line where they border the main channel of the harbor; provision is also made for a measurement of the flats when filled, and a rectification of the price by the results of this measurement. The filling and wall are to be of the same character as the filling and heavy wall prescribed for the flats of the Boston, Hartford and Erie Railroad Company. Six years are given for the completion of the work, except the filling on the line of the flats of the Boston, Hartford and Erie Railroad Company, and the areas to be reserved for streets, which is to be done whenever required by the Board, and on the south-easterly border of these flats, where the company is obliged to fill, whenever the filling begins on the adjoining territory upon the common boundary line. By this arrangement, purchasers of flats beyond those of the Boston and Albany Railroad Company, will be able to fill on their own line without the expense of a bulk-head to retain the material, and will be connected by Northern and Eastern Avenues and B Street with the main land, as soon as the westerly portions of these streets are completed. Upon the failure of the company to improve the flats purchased by it, the Commonwealth by its Board of Harbor Commissioners, will have the right to enter upon these flats and carry out the improvement according to the contract at the company's expense. Since the execution of the contract, the Board, with the approval of the governor and council, has consented, that material dredged from the docks of the Boston and Albany Railroad Company in East Boston, and a bar outside of them, to be deposited on the company's flats in South Boston, on condition that the amount so deposited shall not be reckoned as any portion of grade 13, which is to consist of material dredged from the upper harbor, and more particularly from the area represented by the space colored red on the plan. To the amount that material derived from such sources is used, the filling on the surface with gravel is to be diminished,

except the reservations for streets, where the whole three feet of gravel is to be maintained. The Board makes this discrimination against material taken from the sources stated, because the removal of such material contributes but little to the improvement of the harbor proper, or to compensate for the tide-water displaced by the fillings made in South Boston.

By these two transactions, providing for the immediate improvement of about seventy-five acres, a great scheme has been inaugurated, the completion of which will secure the occupation of a tract of flats some seven hundred and fifty acres in area. It involves the construction of a heavy sea-wall, more than two miles in length, from Fort Point Channel to Fort Independence, and filling to the extent of some seventeen million cubic yards. But it secures proportional benefits. It gives to Boston Harbor an improved tidal regimen, an addition of some five hundred and fifty acres to its deep-water anchorage, an extension of its deep-water frontage sufficient to meet any possible demands of the future, and broad areas for our multiplying workshops and factories, in a locality most favorable for receiving the imported raw materials and distributing through all the avenues of commerce at home and abroad, the manufactured products, at the least cost for transportation. Moreover, what is of prime importance to the prosperity of this community, it brings the trade of the vast West, to the deep water's edge of the chief port of the Commonwealth and New England; the ocean steamer and the railroad train, will be able to meet at the same wharf, and without even stopping the fires of their engines, to exchange their freights, and put them on their respective transits in a swift and saving commerce, such as the age demands. The plan upon which this scheme is carried out, has been matured after years of investigation, study and discussion by engineers, state and national boards of commissioners, committees and legislatures, representing together every interest and every point of view, and undoubtedly is the best that could be devised. In the execution of this scheme, the State incurs but one obligation. It binds itself to remedy any injury that may be found to result to the channels of Boston Harbor, from the loss of scour that may be induced by the displacement of tide-water, which the filling of the flats will cause (Sect. 4, chap. 326, 1868). There is no probability, how-

ever, that the loss to the State from this guarantee, will ever equal its gain from the sale of the flats. Nine hundred and eighty-one thousand one hundred and five dollars (\$981,105) have been already secured to the treasury from the sale of about three-tenths of the first section of the South Boston flats. This sum is nearly twice the amount of the fund (\$500,000), whose income, in the opinion of the United States advisory council, would insure protection against all injuries that might arise from the occupation of the whole section. The effects of this occupation will be a subject of careful observation by the Board, as the work of filling progresses, and every precaution taken that Boston Harbor receive no detriment.

CONTRACTS WITH RIPARIAN PROPRIETORS OF SOUTH BOSTON FLATS.

Simultaneously with the negotiations for these sales of flats, the Board undertook to obtain contracts with riparian proprietors on the northerly shore of South Boston, for the conveyance to the Commonwealth of their flats between the easterly line of B Street, and the westerly line of E Street extended, and going out to the line of the riparian title, one hundred rods from high-water mark. The acquisition of this tract would give the State all the flats in the rear of the first section of the proposed occupation. Their owners have claimed that the State has no right to fill the flats in front of them, and so prevent them from passing out to the channels of the harbor and to sea over the tide-water in front of their property. The Commonwealth has never admitted this claim, but has so far deferred to it, as to provide in the plan for the occupation of the Commonwealth's flats, for the reservation of a channel to the deep water of the harbor, five hundred feet wide, and bordering upon the hundred rod line. This reservation has been preserved, however, in the expectation that an arrangement might be effected which would make it possible to dispense with it without subjecting the proposed improvement to any risk of postponement by a controversy about legal rights. The considerations in favor of the purchase were strong. The discontinuance of the reserved channel for the distance between B and E Streets, would give the Commonwealth some 800,000 square feet of flats that might be sold to be filled. In the possession of the Commonwealth as one parcel, it was believed that these flats would be of more

value than they can be in the hands of many proprietors acting without concert. Nor was it doubted, that if private owners could afford to purchase at substantial prices, and hold for many years this property, that yielded no income and was subject to the annual burden of taxation, the State could afford to hold it for a short time exempt from this burden, especially when, whatever price it paid, would be reduced by the value of so large an area of its flats which would be relieved from the incumbrance of the reservation for a channel. Accordingly, the Board, with the concurrence of the Executive, obtained contracts in writing from all the parties in interest, legally capable of contracting and ready to sell at a reasonable price. It is believed that with the exception of some undivided portions of one lot, the Board will be able to obtain the whole title. Should the owners of these undivided rights still refuse to sell at what all the other shore-owners have agreed to as a fair price, it will be possible, by a partition which shall set off to the State, for the interest it shall acquire, whatever water rights may be appurtenant to the lot in question, to extinguish all claim of right to pass over the waters beyond the hundred rod line, and thus secure the object of the purchase. The legislature of last year, after these contracts had been obtained, appropriated by chapter 446, \$300,000 for the purchase of this tract. The title has been examined, and as soon as some defects are cured and sales are made by persons, who from disability are unable to sell without the sanction of a court, the Board will complete the transaction. It will cover the area upon the plan annexed, shaded blue, beginning 220 feet from First Street, and rights in B, C, and D streets extended, to connect this area with First Street. It costs the State less than \$250,000, or an average of about 11 cents a square foot, for about 2,159,000 square feet of flats. Reckoning at the same price, and deducting from this cost the 805,000 square feet of the channel reservation, the occasion for which is removed by this purchase, the cost to the State will be reduced to about \$154,000, or a little over 6 cents per square foot.

DRAWS AND BRIDGES OVER CHARLES AND MILLER'S RIVERS.

One of the most important subjects upon which the Board advised legislation last winter was the widening and improvement in location of the draws in the bridges over Charles and Miller's

ivers. The bridges over Charles River have long been a standing offence against all principles upon which structures in tide water should be built. The rows of piles on which they rest are at every sort of angle with the line of the current, and greatly obstruct its flow. The draws which, if placed in line with the current and so with each other, would afford an unobstructed water way, and be convenient for the passage of vessels, were really in line with nothing. The seriousness of these obstructions in their merely physical relations will be appreciated when it is considered that the Charles River basin is one of the most important of those tidal reservoirs of Boston Harbor, which keep its channels of the requisite depth for a great port of commerce, and that the river, where crossed by many of these bridges, is the outlet of this reservoir. The maintenance of this basin and the improvement of its outlet has for a long time been regarded as of vital importance to the harbor, and that importance is, if possible, increased with every step taken in the displacement of tide-water in Boston Harbor by the occupation of the South Boston flats. Moreover, the draws in these bridges were not wide enough to accommodate the increasing breadth of beam of vessels carrying the class of freights which were delivered above them. The case was a clear one for reform, and last winter, a favorable opportunity was presented for doing something. The railroad companies were applicants for legislation for their benefit, among them the Boston and Maine Railroad Company, and the Fitchburg Railroad Company, for leave to increase the width of their bridges upon flats of the Commonwealth. Petitions to the legislature, numerous and influentially signed, were also presented for wider passage-ways for vessels. The Board coöperated with the petitioners and endeavored to connect legislation upon this subject in the interest of the public, with the legislation sought for the railroads. It presented a plan for an increased width and a proper alignment of the draws, favorable to navigation and the flow of the tide. A draw, fifty-five feet in width was recommended, in order that a vessel of the largest breadth of beam passing over these waters, might go through with the tug-boat by her side, and a wide waterway be secured for the tide. Without adopting this recommendation to its full extent, the legislature finally provided, in chapters 272, 291, 311, 343 and 352 of the Acts of 1869, that

the commissioners on Charles River and Warren bridges, the city of Cambridge, and all the railroad companies having bridges over Charles and Miller's Rivers, should "forthwith" make in lieu of existing draws in their respective bridges over these waters, "draws with a clear passage-way of forty-four feet in width, in such position, and of such form and construction as the harbor commissioners should determine." At the same time the legislature gave to the Lowell Railroad Corporation the right to build a new bridge over Charles River; a right given also in the interest of the Eastern Railroad Company, as it would enable this company to purchase the bridge of the Lowell Railroad adjoining its own, as the legislature authorized it to do. To the Boston and Maine, and the Fitchburg Railroad Companies was given the right to cover additional flats with pile structures. The locations of all the new draws over Charles and Miller's Rivers, as determined by the Board, and as it is proposed to determine them, are shown upon the plan annexed to this Report. It is substantially the same plan that was submitted to the harbor committee of 1869, who reported the legislation we have cited, and gives besides the additions that the Boston and Maine, and Fitchburg Railroad Companies were allowed to make to their bridges. Plans of draws on the retractile principle have been furnished to the commissioners on the Charles River and Warren bridges, for these bridges, and the draw in the Charles River bridge has been nearly completed in the most satisfactory manner. The Board adopted for these draws the least expensive plan that would answer the purpose, in view of the great probability that these bridges will, at no distant day, be superseded by one bridge with ample spans and roadway, to the great benefit of the harbor, and the convenience of navigation and travel. The Board have also approved plans for widening the draws of the Fitchburg Railroad and the Eastern Railroad bridges over Charles River. The Lowell Railroad Company has failed to submit plans, because it is still undetermined whether the bridge will be transferred to the Eastern Railroad Company or not. The Boston and Maine Railroad Company, against whose strenuous opposition this legislation in favor of unobstructed navigation was passed, has submitted no plan, although often applied to by the Board, or in its behalf. The city of Cambridge sub-

mitted a very elaborate and excellent plan for a pivot-draw in the West Boston bridge, which met the cordial approbation of the Board in all respects, except the location and the construction of the piers. The present draw in this bridge is not in the channel of the river, nor in the place most convenient for the passage of vessels. It is in the line of a continuous shoal above and below. The location selected by the Board is near the middle of the bridge, is in the main deep-water channel, and, as was found by boring, furnishes the best foundation for piers. The city apprehended that the changes in its plan would involve an addition to the cost. It had made its appropriations for the year, and provided for taxation upon a basis of expenditure according to its own plan, and was not inclined to enter upon the construction of the new draw according to the requirements of the Board during the past year, and so withdrew the plans it had presented. The Board have prepared and submitted to the city of Cambridge a plan for piers and location in conformity with their views, at the same time, however, inviting suggestions from the city, in order that some plan may be finally reached, which shall be acceptable to all parties. The Board have no doubt that, for the sum estimated as the cost of the draw, according to the plans submitted by the city of Cambridge, a suitable draw with proper piers can be built in the new location. The city of Cambridge has also been invited to furnish plans for the new draws which the city is required forthwith to build in the Cragie and Prison Point bridges. As no such plans have been submitted, the Board are preparing plans for these draws also, and propose to furnish them to the city, that there may be no reason for delay in this important work, which it is in the power of the Board to remove. The Board have thus far limited all parties to the months of January and February of this year for the obstruction of navigation on Charles River in making the proposed improvements. It is evidence of some of the benefits that may be expected from these improvements, that wharf-owners, on their waters, have already received notice from shippers that when these draws shall have been widened to the required width, the twenty-five cents a ton extra charged on coal when carried above these bridges will be discontinued.

WATER SPACES ON THE BOSTON SIDE OF CHARLES RIVER
BETWEEN THE RAILROAD BRIDGES.

Another important question investigated by the Board with the aid of the United States advisory council, arose out of the application of the Fitchburg, Boston and Maine, and Eastern Railroad Companies, for the right to bridge over the water-spaces lying between their bridges on the easterly side of Charles River. They proposed, in conjunction with this occupation, to build a continuous draw-pier from the Warren bridge to the Eastern Railroad bridge, on the new line of draws. The report of the Board and of the United States advisory council are contained in the Appendix to this Report. The Board acceded to the proposition on condition that the old bridges should be reconstructed, and both old and new built upon rows of piles eighteen feet apart, driven in line with the current, and sheathed to the bottom of the river. The railroad companies regarded the conditions as too onerous, and their application was withdrawn. They claimed that it would cost four dollars a square foot to occupy these areas upon the conditions required in regard to sheathing. The Board do not admit this claim, but are satisfied that, with the aid of sub-marine divers, this sheathing can be done at a cost which would make the expense of occupation in the manner required no serious obstacle to the undertaking. The investigation of this subject has a permanent value; it has established a standard by which to test any scheme of encroachment upon the tide-waters between the West Boston and the Charles River bridges.

BROADWAY BRIDGE OVER FORT POINT CHANNEL.

On the 25th of May, the city of Boston submitted to the Board plans for the construction of an iron bridge over Fort Point Channel, as part of the plan for the extension of Broadway from South Boston to Boston proper. By chapter 188 of the Acts of 1866, the city of Boston received authority to build a bridge over Fort Point Channel in this locality, subject, however, to stringent conditions as to the manner in which the bridge should be constructed. The statute provides that the lines of the piles of this structure shall be driven in the direction of the current, and that it "shall be erected under the direction and supervision of the board of harbor commissioners, and in such manner as

in the opinion of said commissioners shall be in accordance with the mode of construction described and recommended in the seventh report of the United States commissioners on Boston harbor, made to the city of Boston, in the year eighteen hundred and sixty-four." The Board have given the subject the attention which its intrinsic importance and the requirements of the statute demanded. The strength of the proposed structure was carefully computed by Gen. J. G. Foster, in behalf of the Board, and T. Willis Pratt, Esq., appointed by the city of Boston, to superintend the construction of the bridge, the burden to be sustained being calculated at one hundred and fifty pounds per square foot of surface of roadway, and one hundred pounds per square foot of sidewalk, in addition to the full weight of the structure itself. The plan of the bridge over the channel, provides for a pivot drawbridge in the middle of the channel, having two clear openings of not less than 44 feet each, the width prescribed by the legislature for the draws on Charles River, with draw spans of 80 feet each, and at each end of the drawbridge a long span bridge of 100 feet; it provides for a drawbridge pier to be constructed of cast-iron screw-piles of an interior diameter of 24 inches and $1\frac{1}{4}$ inch thickness, to be firmly bolted together and screwed into solid clay bottom, and when set in place, to be filled solid with concrete, for the entire length. The piles of this pier are to be placed 8 feet apart, from centre to centre, around a circle 40 feet in diameter, three piles being set at the centre of the circle in the line of the stream for the pivot of the drawbridge. The plan also provides for a fender pier, enclosing, without contact with, the central pier of the draw, 260 feet long and 60 feet wide, constructed of three rows of 6-inch pine or spruce sheet piling, tongued and grooved and driven in a line parallel with the thread of the stream, 26 feet 6 inches from centre to centre of each row. The whole bridge is to be protected by fender guards of oak piles or sheet piling, extending out from each end of the piers at the ends of the draw spans, to the fender guard line, 18 feet from each side of the bridge, and on this line fender guards of oak piles, 18 feet apart, are to extend to each shore. The draw is to be worked by a caloric engine of at least 3 horse power, and to be furnished with two such engines, one for use and one for reserve. The piers, which are to support the ends of the drawbridge and of the long spans, are to be built of

cast-iron screw piles of the same dimensions as those of the draw-pier, and each to have five piles placed in a line parallel with the direction of the stream and connected with each other by sheet piling, forming a smooth outline to the pier and at each end coming to a point. The piers on the outside ends of the long spans on the South Boston side, do not fall within the channel, and are to consist of three wrought-iron columns, while on the Boston side, the pier at the end of the long span falls within the channel, and is to be like the piers at the other ends of the long spans next to the drawbridge. These are the main features of the plan, as it affects the channel. The recommendations of the United States commissioners on the subject of bridges, in conformity to which this bridge was to be built, are substantially embodied in the following extracts, taken from their seventh report. "We ask that the new bridges shall be so built as to insure the least obstruction to the water-ways. * * * We recommend, too, that the new system should not only comprehend an improvement in the water capacities, but also in the modes of construction. The width as well as the number of bridges has to be regulated ; the piles must be parallel with the stream and favor the outline ; the length of each row of piles measured in a line of direction of the stream must be equal ; the piles should stand close together to avoid the creation of small eddies ; the lateral faces of all piers should be smooth, to create the least friction ; and the offer of any sharp angles to either ebb or flood, should be carefully avoided. * * * There is great room for improvement in the piers of draws. In many cases they exhibit compact masses of piles, which give and are intended to give a sheer to the current, and guide it throughout the draw-way. This is as wrong as it is, so far as we can conceive, uncalled for. The whirls and eddies created by it are inconvenient to navigation, and waste the force of the current. We suggest that the piers on which the bridges rest, should be of stone or iron, or both combined ; and if of stone in the form of a truncated pyramid, allowing an increase of water-way with the rise of the tide. This would conform to nature." It is believed that by the ample widths between the piers, the open draw-pier, the water-ways through the fender pier, the smooth lateral surfaces covered by the sheet piling in the fender pier and around the piers of the spans, the alignment of the piers with the direction

of the stream, the sharp edges presented to the current by bringing the sheet piling enclosure of the piers to a point at each end of the pier, the recommendations of the United States commissioners are met in every particular. The Board regretted the necessity of providing a fender guard along each side of the bridge, to be made of oak piles, driven 18 feet apart, but it was held by the engineers to be required for the protection of the bridge against the effects of collision with heavily laden vessels. The case seemed to have been anticipated by the United States commissioners in the following passage from the report already quoted from. "There is no great objection to planting a single row of piles at large intervals across the channel, and the objection, such as it is, must yield to the necessity of the case."

In its wide spans and the adjustment of its piers to the direction of the current of the channel it crosses, this bridge is a sample of the class of bridges which ought soon to supersede the irregular masses of piles and timber called pile bridges, that so injuriously choke up the outlets to the reservoirs of Boston Harbor.

THE BACK WATERS OF BOSTON.

The requirements of the statute authorizing the construction of Broadway bridge over Fort Point Channel, and the costliness of the structure which the city of Boston has, of its own accord, contracted for, show an appreciation on the part both of the Commonwealth and the city, of the value to commerce, of the waters of South Bay of which the channel is the outlet, and near the mouth of which the bridge is located. The importance of these waters and of the back waters of all great cities can hardly be overestimated. The wharves situated upon them invariably become the centres of accumulation and dispersion for the bulkier class of water-borne merchandise, like coal, lumber, lime, and building materials of all kinds. These are articles which it costs the most in proportion to their value to transport, and the delivery of which near the places of consumption effects a great saving to the public. Railways do not supply the place of commercial water-ways, and can rarely, without public loss, be substituted for them. Whenever they cross each other, the interest of both should be reconciled by the maintenance of properly constructed draws. To destroy the water-ways of com-

merce, merely that the owners of their beds may make land of them, is to subordinate public to private interests; to tax the people for the benefit of a few.

The following quotation, from a very remarkable essay upon the navigable ways of France and its neighborhood, reflects the current of public opinion in Europe, distinctly and clearly. It emanates from a high authority,* and is not without a bearing upon questions discussed among ourselves:—

“Among the least disputed verities of the science of economy, applied to the transportation of materials and the productions of industry, must be placed the importance of the part which belongs to navigable water-ways in the complex work of the distribution and apportionment of that which is called the material wealth of a country. Before railways came to occupy, in the commercial and industrial system, the rank which they merit, watercourses were regarded as offering the means, *par excellence*, of cheap transportation. They had been for centuries the preferred paths, not only for the transit of materials and products, but also, in certain geographical directions, for personal locomotion.

“The invention of railways has modified this state of things, and the great speed given to vehicles which pass over them must attract to them not only passengers, but also an enormous quantity of materials and products, which the slowness inseparable from the ordinary mode of locomotion upon the greater part of our water-ways forbids.

“This radical modification, introduced into the old system of transportation, must exercise a great influence upon the minds even of those most versed in economical studies: it has been believed that railways were going to take the place of water-ways and that the latter would be considered, henceforth, means of circulations incompatible with the necessities of modern industry.

“The most ardent supporters of railways demanded nothing less than the suppression of water-courses, as if there were no greater difficulty in replacing a verity by an error in the economical than in the political system; but errors are of equally short duration in either.

“All this noise and all this agitation time has appeased; practical observation coming to the aid of reflection, has calmed this fever, excited principally by financial speculation, and has contributed in

* *Les Voies Navigables de L'Empire Français, de la Belgique, et des provinces de la Rive Gauche du Rhin, par Alexandre Collin, Ingenieur en Chef au Corps Impérial des ponts et Chaussées.*

great part, to recall the minds of men to the right path from which they had momentarily strayed.

“If serious economical perturbations were provoked by this new and unexpected element, if public opinion was, for some years, carried away, and, as it were, absorbed in the tumult which prevailed, the Imperial government never lost sight of the true interests of industry, commerce, and agriculture, the development of which was so intimately connected with that of navigable waterways, nor permitted the belief that it abandoned these as useless instruments, hereafter incompatible with the development of public wealth. Far from that, it has proclaimed on all occasions that waterways, like railways, were indispensable to the extension of national power; that their coexistence and coöperation were necessary to us in order to secure economical transportation, especially of heavy and bulky merchandise and products, and to enable French industry to sustain, with success and honor, the struggle with foreign labor. We, therefore, render but justice to the government in recalling that it has not ceased to think and declare that the prosperity of waterways and of railways was narrowly allied to that of the country, and that it was in their pacific and regulated concurrence that was to be found the true solution—so long sought and vainly pursued—of the question of cheap transportation, or, in other words, of the most vital question of industry, of commerce, and of agriculture.

“And these principles have been sanctioned by the State.

“It is then true that, if we were to admit, by a kind of antithesis the preëxistence of railways, and the absence of waterways which have preceded them in the economical order, it would be necessary to invent the latter in order to make the requisite counterpoise and indispensable complement of the former, and *vice versa*. Time, which puts everything to rights, will justify more and more this proposition the principle of which is henceforth sanctioned by an experience sufficiently prolonged, to overcome all doubts hereafter upon this economical theorem of which the industrial nations of England, Belgium, Holland and Prussia, no less than France, recognize the truth.”

So great a saving is made in the cost of transportation by such waters as Charles and Miller's rivers, South Bay and Fort Point Channel, that in Europe they are obtained sometimes at immense cost by excavations in the virgin soil, and it is considered public economy to do so. The estimate which the legislature of last year put upon the commercial value of Charles and Miller's

rivers is shown by its legislation for draws of proper width in the bridges over their waters. Its judgment in regard to a portion of South Bay was significantly shown by its emphatic rejection of a proposition, persistently urged, to build a solid extension of East Chester Park across Roxbury Creek, which flows into South Bay, and so destroy the navigation of the upper portion of the creek. It was shown in evidence that the number of vessels that passed in the year 1868 above the line of the proposed extension was 427, and that the merchandise discharged at the wharves in that limited space amounted to about 120,000 tons, costing over a half million of dollars. During the past year the number of vessels that discharged cargoes on Roxbury Creek amounted to 550 ; and the value of the cargoes to \$930,000. The number of passages by vessels through Dover Street bridge amounted, in the year 1868, to 3,848, and in the year 1869, to 4,986, while the wharf property along the westerly shore of South Bay is annually increasing in value. There is good reason, therefore, for establishing a high standard, by which new bridges on Fort Point Channel shall be built, and old ones shall, in time, be reformed.

ATLANTIC AVENUE.

On the 6th day of March, A.D. 1869, the Board approved plans submitted by the city of Boston for the construction of a sea-wall on the easterly side of Atlantic Avenue, under the authority of chapter 324 of the Acts of the year 1867 ; these plans provided for a wall of sufficient strength, and were readily approved by the Board ; the contract transmitted with the plans contained what seemed a sufficient guarantee that the plans would be carried out in this ample provision for superintendence : " All work to be done to the approval of the committee on paving, and the superintendent of streets, or some person appointed by them to superintend the work, and to see that it is faithfully performed according to the contract ; and the term ' superintendent,' as used in these specifications, refers to said superintendent of streets or some person appointed to superintend the work, as above provided." A special superintendent was appointed for the constant supervision of this work, in behalf of the city. Accordingly, the attention of the Board was not directed particularly to this work until the 10th of May following,

when it was called to the fact that the contractors were making serious departures from the plans approved by the Board and the contract with the city, particularly in not dredging the proper trench for the wall before driving the piles and filling in between the piles with gravel and chip ballast. Gen. J. G. Foster examined the matter in behalf of the Board, and reported that this departure from the contract and plan involved a material gain to the contractor, at the expense of the city, and was a serious defect in the construction of the wall. The Board at once notified the committee on paving, and had all the work on foundation that had not been completed and was going on between Long Wharf and Commercial Wharf, arrested. The Board insisted that either the piles should be withdrawn, or a new plan presented for approval, based upon what had already been done, and strengthening the wall in other ways to compensate for not properly dredging out the trench. After a good deal of discussion as to the form a new plan should take, on the 14th of October a modification of the previous plan, and applicable to the wall from Long Wharf to Commercial Wharf, was submitted to the Board by the committee on paving, and on the 21st of October was approved. The work was then resumed. This transaction reluctantly convinced the Board of the necessity of employing an inspector to exercise constant supervision over all important works that are to be done in accordance with plans approved by the Board. They had the less hesitation in incurring the expense of employing such services from the fact that an inspector would be absolutely indispensable to secure proper supervision of the work that is to be done on the South Boston flats under the contracts, of which an account has already been given. Accordingly on the 22d day of September, the Board employed Mr. Charles T. Curtis, of Lynn, a master mechanic, who had had large experience as an inspector upon works of the United States government, to act as an inspector for the Board, and he has diligently and faithfully discharged his duty. The construction of the wall on Atlantic Avenue, according to the modified plan, has gone on under his inspection, and has been satisfactorily done.

It is desirable that some provision should be made for the inspection of work done in distant parts of the State. It is recommended that the Board should have authority, in such cases, to

require that parties building important structures should, before beginning them, give security for the payment of the services of an inspector appointed by the Board to see that the work is done according to the plans.

EAST BOSTON BRIDGE.

It almost never happens that there is any difference of judgment between the state and national governments upon the value of navigable waters or the character of measures that may affect them. Unfortunately, in the case of an Act passed by the legislature of Massachusetts, chapter 352, 1868, to incorporate the Maverick Bridge Company and to authorize it to build a bridge from Boston proper to East Boston across Boston harbor, such a difference of judgment has arisen. The ultimate decision of all such questions rests with the United States; and the decision made in this case is in the interest of the commerce of the harbor of Boston and the navy yard of the United States at Charlestown. On the 7th day of July, 1868, Congress passed the following joint Resolution:—

“Be it Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Navy shall detail two competent and impartial officers of the navy, and the Secretary of War shall detail a competent and impartial officer of the Engineer Corps, who shall compose a commission, whose duty it shall be to make careful examination of the harbor of Boston, and shall report to Congress, at its next session, in what manner the commerce of said harbor and the interests of the United States in the navy yard at Charlestown will be affected by the construction of a bridge over the water between the main land in the city of Boston and East Boston in the manner provided in an act of the legislature of the State of Massachusetts, entitled ‘An Act to incorporate the Maverick Bridge Company,’ and no bridge shall be erected by said company across said water until the assent of Congress shall be given thereto.”

The Commission appointed under this Resolution consisted of Rear-Admiral S. H. Stringham, President, Rear-Admiral C. H. Bell, and Brevet Brigadier-General J. H. Simpson, who, in January, 1869, after a very thorough investigation, made an elaborate report upon the subject to Congress, concluding with the following opinion:—

“1. That the commerce of the harbor of Boston will be very seriously and injuriously affected by the erection of the proposed Maverick Bridge, or by any bridge from Boston proper to East Boston, except a suspension bridge which would allow the passage of vessels of the first class under it at any point.

“2. That the interests of the United States in the navy yard at Charlestown will be very seriously damaged by such bridge.

“3. That a bridge between the points mentioned should not be authorized.”

WAREHAM RIVER.

On the 14th day of October last, complaints were made to the Board in regard to the obstruction to navigation caused by the Cape Cod Railroad Company's bridge over Wareham River. Several hearings were given to parties interested in the subject, and, after an investigation and report by the engineer, the Board came to the conclusion that the shoaling of the river at Wareham is mainly due to the fact that a large part of the railroad bridge and a part of the public bridge which joins it, are built on solid embankments, instead of on rows of piles parallel with the current. This defective construction has been injurious in two ways: first, great quantities of sand and other material have been washed from the railroad embankment and deposited in the river; and, second, the embankments impede and divert its currents. There may be other causes of shoaling in the river, but they cannot be ascertained with any degree of accuracy except by careful surveys, which the Board propose to have made, as soon as the season permits, with a view to the establishment of a harbor line. The Board had no power to remedy the injury which the faulty construction of the bridges has occasioned and may occasion hereafter. The remedy lies altogether with the legislature, and is a proper subject for legislative intervention, as these waters are the centre of very valuable commercial interests.

IMPROVEMENT AND PRESERVATION OF BOSTON HARBOR.

The United States has continued its appropriations to carry out the plans for the improvement and preservation of Boston harbor, submitted by the Board to Congress and the War Department in the winter of 1866-7, as well as to complete work

that had been previously begun. The first appropriation was in 1867, and amounted to \$375,000; the second, of \$43,000, was made in 1868, and \$93,000 was provided last year. These appropriations have been applied to the repair and completion of the walls on Deer Island, Lovell's Island and the Great Brewster, under Major-General H. W. Benham, and to the widening of the main ship channel at the Narrows, the protection by sea-walls of the islands along this channel from washing into the harbor, and the removal of dangerous rocks, under Major-General J. G. Foster. This work has made very satisfactory progress. In the removal of these rocks new methods have been employed, which have attracted much attention in this country and abroad for their novelty and success. Corwin and Tower rocks, and now Barrel rock have been so reduced that twenty-three feet of water covers them at low mean tide. At the special instance of the Board the removal of Kelly's rock has been undertaken, although not yet fully accomplished.

We are permitted to add the following extracts from the reports of Generals Benham and Foster, to General Humphreys, Chief of U. S. Engineers, relating to the harbor works of which they have respectively had charge during the past year. General Benham reports as follows :—

“Since my superintendency of Deer Island, the walls have been rebuilt of the same general height, as thoroughly as possible in mortar, with a concrete backing, from the lowest course upwards, to make an average thickness of about 8 feet, and though the dowells were omitted, long tie stones were introduced into the concrete backing wherever practicable, and, up to the close of 1869, there has been rebuilt on the North Head 1,248 linear feet, on the Middle Head, 540 linear feet, and the whole wall of the South Head, 425 feet, or in all at this island there have been 2,213 linear feet of wall reconstructed, together with two jetties, for the protection of the foundations at the parts peculiarly exposed.

“These jetties are of split stone of 6 to 8 feet in length, set up-right one-half their length in the clay, to form a mass of 6 to 7 feet width in plan, by an extension from the walls outwards, of 25 to 28 feet, the foot of the stone piling being protected by a mass of concrete below the earth surface, around the sides and outer ends 2½ to 3 feet in width and depth.

“The works were closed last autumn from the near exhaustion of

the funds, and although I presume that a further expenditure of \$8,000 to \$10,000 would be judicious in the rebuilding to some further extent of the clay-backed walls of the Middle and North Heads, as still exposed to the injuries described, yet, I am happy to be able to say that no immediate injury is threatened from the delay, and that any future damage could be arrested before becoming serious.

“The expenditure on these reconstructions since 1863 were, up to the time of my charge, or to March 31st, 1866, \$15,438.82; since then to December 31st, 1869, \$60,367.02; and a sum of \$1,016.74 is now on hand available for any small or pressing necessity for either Deer or Lovell’s Island, as the appropriations have generally been available for either island.

“At Lovell’s Island the alarming encroachments upon the ‘Narrows’ at the south-west part, from the abrasion of the Ram Head Hill, caused the appropriation for, and construction of the wall for the protection of this head in 1843. This wall, a model work of its kind, devised and constructed by General (then Colonel) Thayer of the Engineers, extends for about 750 linear feet, covering the remains of this head, with a jetty 80 to 90 feet long, of rough split stone at its west end. In section it showed a foundation of concrete of $1\frac{1}{2}$ to 3 feet deep, with a facing of granite in four to five courses of headers and stretchers dove-tailed and backed with concrete to six feet width, with a coping of heavy stones backed by a boulder paving 25 feet wide. The whole height, including the foundation, ranges from 11 to 13 feet. The expenditure for the wall in the year named was about \$12,896.25; and it has afforded a secure protection against further encroachments on the channel at the point named. In 1849 the jetties constructed cost \$4,221.73, making for Colonel Thayer’s expenditure for this island, \$17,118.21.

“But within a few years past some injuries had occurred to the foundation of this work at its eastern or most exposed end, which threatened its destruction, and the wearing away of the east bluff of the south hill, about 500 yards south of this wall, caused the application for funds for protecting these parts; and in the past two years I have repaired the injuries to the main wall, by sinking stone piles, some 5 to 8 feet long, one-half their length below and in front of the abraded foundation; protecting the foot of this with concrete 2 to $2\frac{1}{2}$ feet wide and deep; and by the construction of two split stone jetties with a base of concrete, near the east end, of a character like those described for Deer Island.

“And for the protection of the South-East Head, there has been

planned and constructed a wall of minimum height and size, but which has proved most satisfactory for the purposes desired.

"This wall is of about 800 feet in length, with jetties as above described at each of its four angles. It consists of a 2 feet foundation of concrete, three courses of headers and stretchers backed by concrete and a coping course (in all 8 feet of stone facing) of heavy stones, alternate double headers and truncated, lozenge-shaped stones that I devised for holding the whole course together without dowells, this coping being backed by a paving of boulders; and this wall of 10 feet in height only by about that thickness, by the directions given to its lines, has proved thus far most successful and ample for the protection required not only to the bluff but to its own foundation.

"The expenditures for this island have been, by or for Colonel Graham, from 1864 to March, 1866, about \$2,000 for buildings, &c., that he had erected, and since that time to include 1869, by myself \$37,479.45.

"The shores are now in good condition, and but little more seems necessary to protect this island, except a small amount of work, of, perhaps, \$1,000 cost to re-build or re-arrange the jetty at the west end of the old wall, which was prevented by some difficulty in controlling the contractor, as the funds could be expended by contract only.

"As to the Great Brewster, the largest island, and from which the greatest amount of danger was apprehended, about twenty years ago, or in 1849, I was placed in charge of the construction of this wall, upon plans furnished by Colonel (now General) Thayer, then in principal charge of the works in this harbor. These plans contemplated a wall along the exposed and abraded parts of each bluff or head, with a 'rip rap' of rough stones on the seaward side of the space between them. The wall was to be without the high-water line and on a base of concrete $2\frac{1}{2}$ feet thick set $3\frac{1}{2}$ feet above mean low-water, then to have a granite facing of eight courses averaging 2 feet high, of headers and stretchers dove-tailed, with a backing of concrete to make the average thickness about 8 feet, with a coping course of 2 feet high by 5 feet wide backed by large "shell stone" laid on gravel and boulders to 15 feet width to meet the heavy fall of the sea after dashing against the front, the whole wall being about $20\frac{1}{2}$ feet in height.

"This work commenced by me in 1849, was continued in that year, and the next, to the protection of the South Head, east face by a wall of 380 linear feet, and the south part of the east face of the North Head for some 320 feet, or 700 feet in all, to the exhaus-

tion of the first appropriation of \$40,000, over half of which was paid for the cut stone, of which about \$9,500 worth remained on hand for use.

“In 1851 about \$4,000 was expended by me for repairs to injuries to the unfinished wall in the great gale of that year.

“In 1853 and '54, work was resumed under Colonel Thayer, with a new appropriation, and the wall of the North Head was extended by 640 feet, and again in 1865, under Colonel Graham, during which year, the wall on the south face of South Head was constructed to the westward to the amount of 164 feet. The expenditure from 1853 to March 1866, being \$89,403.06 (under Colonel Thayer, \$24,705.90, and Colonel Graham \$64,697.16).

“In 1866–67–68 the wall was carried around the north and north-west part of the North Head as far as appeared necessary, making 1,672 feet in all for that head, with four split stone jetties like those above described.

“And it was also completed to protect the south face of the South Head, making in all for that head some 917 linear feet of wall, with a large jetty of 50 feet by 12 to 14 wide of split stone laid dove-tailing over a core of boulders at the south-east angle, (this, however, was built in 1851,) and at the south-west angle a large split stone jetty of about 8 to 10 feet wide and 50 feet long, like those described for Deer Island, has been placed; all these jetties being invaluable and indispensable at certain parts for the protection of this wall.

“As it was found, however, that when the source of supply on the North Head was cut off, the bank of drift on the space between the two heads, about 250 feet, was being lowered and carried inward, it was feared that the islands might again be separated by the rush of the sea in storms, and the immense mass of drift on the several acres of the flat land inside be borne out on the spit towards Fort Warren, to the probable *closure* or *destruction* of the main channel there; it was recommended and approved by the department that this space should be closed up by a wall similar to those already built; \$25,000 being allotted therefor in the year 1869. And during the past year the space has been closed by such a wall (with indented joints to the coping, like the new wall at Lovell's Island) and with a split stone jetty of the usual size at the north end at its junction with the old wall. And the walls of this island now give security to its whole eastern, northern, and southern faces, and to the extent of 2,840 feet with the necessary protecting jetties as far as appears to be required at this time; and though a small amount of earth-backing and boulder paving is needed in one or

two places, a month's work, perhaps, for which the funds on hand will suffice, the protecting structure may be considered as fully complete, and at a cost since March, 1866, including \$3,210.84 now on hand, of \$143,679.49, or a *total cost* altogether since April, 1849, of \$277,082.55.

"The completion of this Great Brewster wall, as now reported, with those on the other windward islands and the wall building on Gallop's Island, I think can surely be relied upon, as giving full security against any future serious encroachments on the main channels of Boston Harbor from these sources."

General Foster reports as follows:—

"I have the honor to make the following Report of the progress made in the works of improvement in this harbor, and in Provincetown Harbor, Cape Cod, for the year ending December 31, 1869.

"The improvements in this harbor consist principally in deepening and widening the channel by dredging; in removing rocks that obstruct the channel, or endanger its navigation, by means of sub-marine drilling and blasting; and in protecting and preserving the headlands of the main land and of the islands bordering the channel by means of sea-walls, to prevent their being worn away by the waves, and their material from being washed into the channel, and thereby shoaling it.

"At the south-west point of Lovell's Island, dredging operations were continued during the year, and about 70,000 cubic yards of material were removed during that time.

"The area dredged since the commencement of operations at this point embraces about 19,000 square yards, and the average depth obtained over this area is about 20 feet at mean low water.

"The channel at this point has been widened from 365 feet at the 18 feet curve, to 625 feet, with an average depth over the dredged area of 21 feet.

"If the necessary appropriations estimated for to complete this work (of \$75,000) is passed by the present Congress, the work will be carried to completion during the working season of 1870, which will increase the width of the channel at this point from 365 feet, as stated above, to 685 feet at the 18 feet curve, and an average depth of 23 feet over the dredged area.

"Work was commenced at the Upper Middle Bar during the year. The 'hard pan' of the bottom, however, was of such a tenacious character, that the dredging machine was unable to remove the material. The machine will require to be strengthened

materially before it will be able to perform the work required with satisfaction to the government and a reasonable profit to the contractor. If an appropriation is made by Congress as estimated for by me, (\$100,000,) the work will be pushed during the next working season.

“Work on the sea-wall at Gallop’s Island has been continued energetically and satisfactorily by the contractor. About 800 feet of wall have been built during the past year. The wall will be carried to completion during the next season, provided the necessary appropriation is made by Congress, the amount estimated for being \$60,000.

“The title to the land for the position of the wall for the preservation of Point Allerton, with the slopes in rear, having received the approval of the attorney-general of the United States, proposals for the construction of this wall will be invited during the present winter, in order that the work may be commenced early in the ensuing spring.

“The owner of the beach in this vicinity has declined to give me permission to construct a wharf on the inside of this point, and as no appropriation has been made by Congress to pay for this privilege, as demanded by the owner, I shall be compelled to construct a wharf on the outside, where it will be exposed to the high waves of the open sea. Should it, however, be found to be too dangerous and expensive to construct a wharf at this point, the work will have to be delayed until further action is taken by Congress, unless the legislature of Massachusetts should see fit to use its authority, and authorize the construction of the wharf at the desired point.

“The legislature of the Commonwealth having passed an act directing a jury to be empanelled, for the purpose of estimating the amount to be paid by the United States for the land to be used for the construction of the sea-wall for the preservation of north head of Long Island, as well as a fortification, a jury was summoned accordingly, and the damage to the owners decided upon. Some of the owners, however, appealed to the supreme court. This court has sustained the decision of the superior court, and as soon as the money is paid by the United States, work upon this wall can be commenced.

“After the successful completion of the removal of Tower and Corwin Rocks, at a comparatively small cost, the removal of Barrel Rock, in Broad Sound Channel, and Kelly’s Ledge, in the main ship channel, was decided upon.

“Barrel Rock, by its distance from the shore, and the small depth

of water upon it,—only four feet,—rendered it, in thick weather, a dangerous obstruction to navigation; as, at such times, the shore cannot be seen, nor even the buoys which mark its position. Operations were commenced upon this rock in June, and the entire rock removed to a depth of $22\frac{1}{2}$ feet at mean low water, (which is below the bottom of the channel in the immediate vicinity,) at an expense of about \$6,000.

“Immediately after the completion of this work, the working vessel was removed to Kelly’s Rock, and operations commenced for its removal.

“Work was continued upon this rock until the latter part of December, and about 180 tons of the rock were removed, by being either deposited on shore or removed to deep water.

“About two months’ work during next season will complete the removal of this rock to a depth of 23 feet at mean low water.

“The advantages which will accrue to navigation by the removal of this rock will be the avoidance of the present angle in the sailing line between the ‘Centurion Rocks’ and ‘Kelly’s Rock,’ as a direct line can be followed then from ‘Boston Light’ to ‘Great Brewster Spit Light,’ which will pass directly over the present position of ‘Kelly’s Rock,’ and leave the Centurion Rocks farther to the south.

“During the past year, the dike across the Salt Meadows and East Harbor Creek, constructed for the purpose of preventing the sea from breaking through into the main harbor at Provincetown, should the ocean at any time, during some violent storm, break through the outer or sea beach, has been completed.

“A brush bulkhead and jetties, to connect a similar structure built during 1868, at Beach Point, with the dike built by the State of Massachusetts, has also been constructed and finished during the past year.

“Both of these structures have been well and firmly built, the brush bulkhead and jetties having proved admirably adapted to the purpose for which they were intended, i. e., gathering the floating sand, thus continually strengthening the beach.

“Amount estimated for, for the fiscal year ending June 30, 1871, for the further and complete protection of this valuable harbor, \$25,000.”

* * * * *

PLANS APPROVED.

Under section 4 of chapter 149 of the Acts of the year 1866, the Board has approved, during the past year, plans for the following structures:—

The extension of a pile wharf at or near Nipper Stage (so called), in Nahant, by Mrs. Fenno Tudor, under the authority of chapter 230 of the Acts of 1868. (Approved January 1.)

The construction of a sea-wall and platform between Lewis' and Rowe's wharves, by the city of Boston, authorized by chapter 324 of the Acts of 1867. (Approved March 6.)

The extension of a pile wharf in the harbor of Holmes' Hole by Daniel W. Stevens, under the authority of chapter 67 of the Acts of 1869. (Approved April 28.)

The construction of a solid wharf and pile wharf on the northerly side of Weymouth Great Hill, in the town of Weymouth, by the Pilgrim Wharf Company, under the authority of chapter 173 of the Acts of the year 1869. (Approved June 3.)

The construction of a bridge across Fort Point Channel by the city of Boston, under the authority of chapter 188 of the Acts of the year 1866. (Approved June 8.)

The extension of a wharf on piles in Weymouth Back River by W. L. Bradley, under the authority of chapter 439 of the Acts of the year 1869. (Approved July 21.)

The extension of a wharf on piles in the harbor of Gloucester by John Pew, under the authority of chapter 190 of the Acts of the year 1867. (Approved August 6.)

The extension of a road over River-Head Beach by the town of Marblehead, under the authority of chapter 55 of the Acts of the year 1869. (Approved August 11.)

The construction of a new draw in Charles River bridge, by the Commissioners on Charles River and Warren bridges, under the authority of chapter 272 of the Acts of the year 1869. (Approved August 11.)

The extension of a wharf on piles in the harbor of Gloucester by Joseph Friend, under the authority of chapter 190 of the Acts of the year 1867. (Approved September 25.)

The extension of a wharf on piles in the harbor of Gloucester by Walen and Allen, under the authority of chapter 190 of the Acts of the year 1867. (Approved September 25.)

The construction of a new draw in Charles River bridge by the Commissioners on Charles River and Warren bridges, upon modified specifications, under the authority of chapter 272 of the Acts of the year 1869. (Approved October 7.)

The construction of a sea-wall on Atlantic Avenue, between

Long and Commercial Wharves upon a modified plan, by the city of Boston, under the authority of chapter 324 of the Acts of the year 1867. (Approved October 20.)

The construction of a pile structure on the southerly side of the Fitchburg Railroad bridge on Miller's River, by the Fitchburg Railroad Company, under the authority of chapter 335 of the Acts of the year 1867. (Approved October 21.)

The widening of the Fitchburg Railroad Company's bridge across Charles River, under the authority of chapter 352 of the Acts of the year of 1869. (Approved November 10.)

The widening of a draw in Charles River by the Fitchburg Railroad Company, as required by chapter 352 of the Acts of the year 1869. (Approved December 6.)

A new draw on the West Boston bridge, submitted by the Board to the city of Cambridge, under the authority of chapter 311 of the Acts of the year of 1869. (Approved December 22.)

The widening of a draw in Charles River by the Eastern Railroad Company, as required by chapter 291 of the Acts of the year 1869. (Approved December 29.)

Considerable time has also been given in coöperating with the city of Newburyport and town of Salisbury in maturing a plan for a new bridge across Merrimack river.

COMPENSATION.

The Board have received and paid over to the treasurer of the Commonwealth, to be placed to the credit of the compensation fund for Boston harbor, under section 4, chapter 149, 1866, \$2,135.98, paid by the Boston, Hartford and Erie Railroad Company; and \$75 paid by Malachi Clark, under chapter 162, 1868.

The question of assessing compensation upon the city of Boston for the tide-water displaced by the construction of Atlantic Avenue under chapter 334, 1867, is pending before the Board, the city having appeared by its solicitor to oppose such action. The amount of tide-water displaced by Atlantic Avenue is computed, by the engineer of the Board, at 168,528 cubic yards.

• DUPLICATION OF THE UNITED STATES COAST SURVEY MAPS FOR MASSACHUSETTS.

The increasing demand for a more perfect knowledge of the harbors and shores of the Commonwealth, such as accurate

surveys alone can give, has made the want of such surveys outside of Boston harbor, a serious embarrassment to the Board in their investigation of the subjects referred to them. The possession of the results of the Coast Survey would supply the needed data. Arrangements can be made with the superintendent of the Coast Survey, and with his office, by which copies of the original maps can be obtained. This will give to the State, for the mere expense of copying, surveys that have cost the general government several hundred thousand dollars. Prof. Peirce, the superintendent of the United States Coast Survey, is willing not only to coöperate with the Commission in this undertaking, but urges its accomplishment as a measure of advantage and value to the government and to the State by providing *duplicates* of the original maps. The only record of these expensive and elaborate surveys is contained in the original maps, which are on a larger scale than any of those engraved and published.

The Coast Survey Department would favor any arrangement which would secure a duplication of these maps and their safe deposit in the archives of the various States; in fact, the practical execution of some plan effecting this general result has been for some time a matter of consideration by this department. Hardly any state bordering on the Atlantic has a greater extent of coast or more important harbors, in proportion to its territory, than Massachusetts, and, therefore, none is more interested in securing accurate knowledge in regard to them.

The number of the original topographical maps of the Coast Survey covering our state territory is between fifty and sixty. These are on the large scale of $\frac{1}{100000}$, or about six inches to the mile, and generally extend back from the coast line to the first shore road giving land communication from port to port. Added to these would be the in-shore hydrographical maps, which are fewer in number.

The copying of these maps will be a work of probably some two or three years, as it would not be desirable to organize a large office force to accomplish it in a more rapid manner, and all the maps could not be spared from the office of the Coast Survey, for this purpose, at one time.

The Board would be particularly favored in this work by the service of their engineer, H. L. Whiting, who is one of the

senior officers of the Coast Survey and chief of its department of field topography.

We are unable at this time to give a detailed estimate of the cost of the entire work proposed, but will submit one should it be required. In general terms, the following estimate is submitted :—

60 topographical maps, at \$200 each,	\$12,000 00
40 hydrographical “ “ \$150 “	6,000 00
Office and other incidental appliances, \$1,000 a year for three years,	3,000 00
	<hr/>
	\$21,000 00

One-third of this amount would be sufficient as a first appropriation, \$7,000 00

It is safe to state that the general government has expended, in its survey of the coast of Massachusetts, not less than \$500,000, the practical benefit and value of which can be possessed by the State government at a cost of but about \$20,000.

ENGINEERS.

To supply the place of Engineer of the Board, made vacant by the resignation of Mr. Albert Boschke, Prof. Henry L. Whiting, an assistant in the United States Coast Survey, has been employed, with the consent and approbation of Prof. Benj. Peirce, the superintendent of the United States Coast Survey. The Board considers itself fortunate in being able to secure the services of so skilful and distinguished a hydrographical engineer. In matters of constructive engineering, upon which, in approving plans of walls, bridges and wharf structures, the Harbor Commissioners are continually obliged to act, the Board has, during the past year, employed, to its great advantage, the services of Gen. J. G. Foster, of the United States Engineer Corps, in charge of government works in Boston Harbor.

WORK OF THE OFFICE.

The work of the office for the last twelve months has been unusually large. Thirty-six different localities, in different

parts of the State, from the Merrimack River to Buzzard's Bay, have been examined and surveyed or sketched; thirty-eight reports, in writing, have been made, and eighty-five maps and plans have been drawn, in addition to a large amount of work done which does not take a permanent shape in the archives of the office. The detailed report of the Engineer of the Board is added in the Appendix.

UNITED STATES ADVISORY COUNCIL.

The Board continues, in all important matters, to have the benefit of the advice of the United States advisory council, consisting of Gen. A. A. Humphreys, Chief the United States Engineers, Prof. Benjamin Peirce, Superintendent of United States Coast Survey, Rear-Admiral C. H. Davis, and Prof. Henry Mitchell, Assistant in the United States Coast Survey. During the last two years, the absence of Admiral Davis on naval service has deprived the Board of his valuable counsel. His welcome return, as also that of Mr. Mitchell from his investigations of harbor improvements in Europe in behalf of the United States government, restores to the council its full complement. The value of its coöperation in the solution of difficult questions and in securing harmony of action and opinion between the State and national authorities in regard to navigable tide-waters, over which both governments exercise jurisdiction, cannot be overestimated.

JOSIAH QUINCY,
S. E. SEWALL,
DARWIN E. WARE,
F. W. LINCOLN, JR.,
J. N. MARSHALL,

Board of Harbor Commissioners.

A P P E N D I X.

DEED OF THE BOSTON WHARF COMPANY TO HARVEY AND OTHERS, TRUSTEES.

Know all men by these presents, That the Boston Wharf Company, a corporation duly established under and by virtue of the laws of the Commonwealth of Massachusetts, in consideration of thirteen hundred and fifty thousand dollars paid by Peter Harvey, of Boston, in the county of Suffolk, James S. Whitney, of Brookline, in the county of Norfolk, and Henry B. Groves, of Salem, in the county of Essex, all in said Commonwealth of Massachusetts, the receipt whereof is hereby acknowledged, do hereby remise, release and forever quitclaim unto the said Harvey, Whitney and Groves, all the right, title, interest and estate which the said Boston Wharf Company has, or is by right entitled to, in and to a certain parcel of land and flats situate in that part of said Boston called South Boston, and bounded and described as follows, to wit: Beginning at the south-easterly corner thereof, where the same adjoins the flats formerly sold by the said Boston Wharf Company to Samuel Downer, and marked A on the plan to be recorded herewith; thence running westerly, and bounded southerly by said Downer's land and flats, about one hundred and twenty-three feet to a point marked B on said plan, at the bottom of the sea-wall; then turning and running northerly by the base of the sea-wall about two hundred and sixty feet to the north end of said sea-wall; then running northerly, and a little more westerly, by a line parallel to A Street, and distant two hundred and sixty-three and twenty-six one-hundredths feet easterly from the easterly line of said A Street to a point marked D on the plan aforesaid, in the northerly limit or line of the Boston Wharf Company's territory, as fixed and determined by the statute of the Commonwealth aforesaid, passed in the year eighteen hundred and fifty-two; then turning and running westerly, parallel with West Broadway, about two hundred and ninety-three and seventy-nine one-hundredths feet to a point marked E on the aforesaid plan, at the centre of A Street extended;

then turning and running northerly by the centre of A Street extended, to a point marked F on said plan, in the centre of a street shown on said plan, but not named; then turning and running westerly by and through the centre of said last mentioned street to a point on Fort Point Channel marked G on said plan; then turning and running northerly by Fort Point Channel to a point marked H on said plan, in the Commissioners' line B of any structure, as established by statute of the Commonwealth aforesaid, or as far northerly as the Boston Wharf Company have a right to go; then turning and running easterly on the said Commissioners' line B, or by the northern boundary of the land and flats of the Boston Wharf Company, to the point marked I on said plan, or as far as the land and flats of the Boston Wharf Company extend; then turning and running southerly by the easterly boundary of the land and flats of the said Boston Wharf Company, by two lines, to the point begun at, marked A on said plan: containing by estimation about two million six hundred thousand square feet of land and flats (subject to the right of way of the Boston, Hartford and Erie Railroad Company across that portion of the said land and flats upon which their track is located and built, not exceeding twenty-six feet in width; subject also to a right of way and of passing and repassing reserved by the said Boston Wharf Company, for the benefit of said company, its agents and servants, its successors and assigns, through and over that part of the premises conveyed, embraced within the lines of Granite Street extended, or to be extended, northwardly to the Eastern Avenue, so called, as located, or to such other avenue as shall be built instead of said Eastern Avenue across Fort Point Channel, to connect the premises conveyed with the city proper, and also through and over the said Eastern or other avenue, if located and built upon, or over any part of said premises conveyed, and wherever built), together with the right to lay vessels, and to receive wharfage and dockage therefor, in Fort Point Channel, on the westerly side of the premises conveyed, and upon the northerly and easterly sides of said premises, so far as said right is owned and can be conveyed by said Boston Wharf Company, and all other rights, easements, privileges and appurtenances to the described premises belonging or in anywise appertaining.

To have and to hold the above released premises, with all the privileges and appurtenances to the same belonging, to the said Harvey, Whitney and Groves, and their heirs and assigns, to their use and behoof forever.

In witness whereof, the said Boston Wharf Company hath hereto caused its corporate seal to be affixed, and these presents to be subscribed by Jacob Sleeper, its president, who is thereto duly authorized, this twentieth day of November, in the year of our Lord eighteen hundred and sixty-eight.

BOSTON WHARF COMPANY, by

JACOB SLEEPER, *President*.

[SEAL.]

Signed, sealed and delivered in presence of

A. C. WASHBURN.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK SS., BOSTON, July 24, A. D. 1869.

Then personally appeared the within-named Jacob Sleeper, and acknowledged the foregoing instrument to be the free act and deed of the said Boston Wharf Company, Before me,

A. C. WASHBURN, *Justice of the Peace*.

At a special meeting of the stockholders of the Boston Wharf Company, held upon due and legal notice on Thursday, July 8th, A.D. 1869 (a quorum being present and voting thereon), it was

Voted, That the president of this company be, and he hereby is authorized and instructed to execute and deliver to the Commonwealth of Massachusetts, and to the Boston, Hartford and Erie Railroad Company, and to Peter Harvey, James S. Whitney and Henry B. Groves, any and all deeds and other instruments in writing, which the board of directors shall by vote approve.

Voted, That Jacob W. Pierce, Elisha Atkins and William Morton, trustees, under the mortgage to be given to secure the payment of \$1,200,000 of the bonds of the Boston, Hartford and Erie Railroad Company, all of which bonds will belong to this company, be and they hereby are authorized and instructed to execute and deliver to the Commonwealth of Massachusetts, and to the Boston, Hartford and Erie Railroad Company, and to Peter Harvey, James S. Whitney and Henry B. Groves, any and all deeds and other instruments in writing, which the board of directors shall by vote approve, and that this company will hold said trustees harmless and indemnified therefor.

A true copy from the record.

Attest:

A. C. WASHBURN, *Clerk*.

At a meeting of the board of directors of the Boston Wharf Company, held on Saturday, July 24th, A. D. 1869 (a quorum being present and voting), it was

Voted, That the president of this company, be and he hereby is authorized and instructed to execute and acknowledge on behalf of the Boston Wharf Company, their deed dated November 20th, 1868, conveying to Messrs. Harvey, Whitney and Groves, certain parts of the lands and flats of the said company at South Boston, and to deliver the same in consideration of the note for one hundred and fifty thousand dollars, and of bonds for twelve hundred and fifty thousand dollars, made and to be made by the Boston, Hartford and Erie Railroad Company, issued under the sanction of the governor and council, and secured by mortgages to said Boston Wharf Company, and to Messrs. Pierce, Atkins and Morton, trustees for the holders of said bonds.

Voted, That the president of this company, be and he hereby is authorized to execute, acknowledge and deliver at the same time with the deed afore-mentioned, an agreement with the afore-named railroad company, dated November 20, 1868, as to the payment of their note for \$150,000; and also the indenture of five parts, dated July 21, 1869, wherein and whereby certain parts of the lands and flats formerly owned by the said wharf company, are released to the Commonwealth of Massachusetts, and also an agreement, dated July 21, 1869, that nine months' notice of sale in case of default under the mortgages made to the said Boston Wharf Company, and Pierce, Atkins and Morton, trustees, shall be given to the governor of said Commonwealth.

Voted, That Messrs. Pierce, Atkins and Morton, trustees for the holders of bonds of the Boston, Hartford and Erie Railroad Company, issued to and at present owned by the Boston Wharf Company, be and they hereby are instructed to execute and deliver an agreement, dated July 21, A. D. 1869, to give to the governor of the Commonwealth of Massachusetts, nine months' notice of sale under the mortgage made to them, to secure the payment of said bonds in case of default or breach of the conditions of said mortgage, and also to execute and deliver the indenture of five parts, dated July 21, 1869, whereby certain parts of the flats mortgaged to them, are released to the Commonwealth of Massachusetts.

A true copy from the record.

Attest :

A. C. WASHBURN, *Clerk*.

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER, BOSTON, July 26, 1869.

Ordered, That the consent of the governor and council, be and the same is hereby given to the Boston, Hartford and Erie Railroad Company, to issue bonds to the amount of twelve hundred thousand dollars, in sums of not less than two hundred dollars each, to be dated November 20th, 1868, payable in twenty years from their date, and bearing interest at the rate of seven per cent. per annum, payable semi-annually, to pay for land and flats purchased by or for it, of the Boston Wharf Company, and that said bonds may be secured by a mortgage of the premises so purchased. This consent is made pursuant to the provisions of chapter 456, of the Acts of the year 1869.

Adopted in council, July 26, 1869.

OLIVER WARNER, *Secretary.*

COMMONWEALTH OF MASSACHUSETTS.

SECRETARY'S OFFICE, BOSTON, July 26, 1869.

A true copy of the foregoing order.

Attest:

OLIVER WARNER, *Secretary.*

MORTGAGE OF HARVEY AND OTHERS, TRUSTEES, TO
THE BOSTON WHARF COMPANY.

Know all men by these presents, That we, Peter Harvey of Boston, in the county of Suffolk, James S. Whitney of Brookline, in the county of Norfolk, and Henry B. Groves of Salem, in the county of Essex, all in the Commonwealth of Massachusetts, in consideration of one hundred and fifty thousand dollars paid by the Boston Wharf Company, a corporation duly established under and by virtue of the laws of the Commonwealth of Massachusetts, the receipt whereof is hereby acknowledged, do hereby give, grant, bargain, sell and convey unto the said Boston Wharf Company, its successors and assigns forever, a certain parcel of land and flats situate in that part of Boston called South Boston, and bounded and described as follows, to wit: Beginning at the south-easterly corner of the land and flats conveyed by the said Boston Wharf Company to the said Harvey, Whitney and Groves, by deed of even date and to be recorded herewith, where the same adjoin the flats formerly sold by the said Boston Wharf Company to Samuel Downer, and marked A on the plan recorded herewith; thence running westerly, and bounded southerly by said Downer's land and flats, about one hundred and twenty-three feet to a point marked B on said plan at the bottom of the sea-wall; then turning and running northerly by the base of the sea-wall about two hundred and sixty feet to the north end of said sea-wall; thence running northerly and a little more westerly by a line parallel to A Street, and distant two hundred and sixty-three and $\frac{2}{100}$ feet easterly from the easterly line of said A Street, to a point marked D on the plan aforesaid in the northerly line or limit of the Boston Wharf Company's territory, as fixed and determined by the statute of said Commonwealth passed in the year eighteen hundred and fifty-two; then turning and running westerly parallel with West Broadway about two hundred and ninety-three and $\frac{7}{100}$ feet to a point marked E on the aforesaid plan at the centre of A Street extended; then turning and running northerly by the centre of said A Street to a point marked F on said plan in the centre of a street shown on said plan, but not named; then turning and running westerly by and through the centre of said last mentioned street to a point on Fort Point Channel marked G on said plan; then turning and running northerly by Fort Point Channel to the "Commissioners' line A of solid filling," as established by statutes of the said Commonwealth; then turning and running easterly by said "Commissioners' line A of solid

filling," about twelve hundred and fifty-one and $\frac{15}{100}$ feet, or as far as the said Boston Wharf Company owned and conveyed by their deed afore-mentioned to the said Harvey, Whitney and Groves; then turning and running southerly by the flats of the said Commonwealth and others on two lines to the point begun at;—containing about one million square feet of land and flats, and being all that portion of the land and flats so as aforesaid conveyed to the said Harvey, Whitney and Groves, by the said Boston Wharf Company by deed of even date herewith, which lies south of the said Commissioners' line A of solid filling, subject to the right of way across that portion of the said granted land and flats over which the Boston, Hartford, and Erie Railroad Company is located and built, not exceeding twenty-five feet in width, and subject also to the right of way and of passing and repassing through and over that part of the said granted premises embraced within the lines of Granite Street extended, or to be extended northwardly to the Eastern Avenue, so called, as located, or to such other avenue as shall be built instead of said Eastern Avenue across Fort Point Channel to connect the premises conveyed to the said Harvey, Whitney and Groves by the said Boston Wharf Company, with the city proper, and also through and over said Eastern or other avenue if located and built upon, or over any part of the premises herein and hereby conveyed, and wherever built, as reserved by said Boston Wharf Company in their said deed to the said Harvey, Whitney and Groves, together with the right to lay vessels on the westerly side of the granted premises on Fort Point Channel, and also upon the easterly side of the said premises, so far as the said Harvey, Whitney and Groves possess the said right to lay vessels on said easterly side, under the deed to them from the Boston Wharf Company.

To have and to hold the above granted premises with all the rights, privileges and appurtenances to the same belonging, to the said Boston Wharf Company, their successors and assigns, to their own use and behoof forever.

And we, the said Harvey, Whitney and Groves, for ourselves and our heirs, executors and administrators, do covenant with the said Boston Wharf Company, their successors and assigns, that the above-granted premises are free from all incumbrances made or suffered by us, except as herein before stated, and that we will and our heirs, executors and administrators shall warrant and defend the same to the said Boston Wharf Company and their successors and assigns forever against the lawful claims and demands of all persons claiming or to claim by, through or under us.

Provided, nevertheless, that if the said Harvey, Whitney and

Groves, their heirs, executors or administrators, shall pay or cause to be paid unto the said Boston Wharf Company, their successors or assigns, the sum of one hundred and fifty thousand dollars in six years from the day of the date hereof, with interest on said sum after three years from said date, at the rate of seven per cent. per annum, payable half yearly, and until such payment, shall pay all taxes, all water rates and charges for improvements or betterments, for sewerage, for opening or paving streets, and all assessments of any kind whatever, municipal, State or national, levied or assessed, upon, or in respect of the granted premises or any part thereof, then this deed, as also a certain promissory note made by the Boston, Hartford and Erie Railroad Company, bearing even date with these presents, whereby for value received the said Boston, Hartford and Erie Railroad Company, promise to pay to the said Boston Wharf Company, or order, the said sum and interest at the times aforesaid, shall both be absolutely void to all intents and purposes.

And *provided, also*, that if default shall be made in the payment of the money above-mentioned, or of the interest that may accrue thereon, or of any part thereof, or of the taxes, assessments or charges above referred to, then it shall be lawful for the said Boston Wharf Company, acting through its president or treasurer or other authorized agent, or their successors or assigns, to sell and dispose of the granted premises, with all the improvements that may be thereon, at public auction; such sale to be upon the premises hereby granted, without further notice or demand, except giving notice of the time and place of sale by advertising twice in each of three successive weeks, in three daily newspapers, printed in the city of Boston aforesaid; and the said Boston Wharf Company, or its assigns, in its or their own names, or by its president or treasurer, or other authorized agents, as the attorney of the said Harvey, Whitney and Groves, by these presents for that purpose duly authorized and empowered, may convey the same absolutely and in fee simple to the purchaser or purchasers accordingly. And out of the money arising from such sale to retain all sums then secured by this deed, whether then or thereafter payable, together with interest and all costs and expenses, including all sums paid or to be paid by the grantees, as and for taxes or assessments or levies of any kind above referred to; and to pay the surplus, if any, to the said Harvey, Whitney and Groves, or their representatives or assigns, or to the court ordering or confirming such sale; and such sale shall forever bar the said Harvey, Whitney and Groves, and each and all of them, and all persons claiming under and through

them, from all right and interest in the premises or any part thereof, at law or in equity.

It being mutually agreed that the said Boston Wharf Company, its successors or assigns, may purchase at said sale, and that no other purchaser shall be answerable for the application of the purchase money. And it is further mutually agreed that in case of default in the payment of the aforesaid sum, or of the interest or taxes, at the election of the said Boston Wharf Company or their assigns, an entry may be made upon the granted premises, and possession thereof may be taken and maintained by or on behalf of said Boston Wharf Company or their assigns, for foreclosure of this mortgage, which being continued for three years from and after such entry shall forever at law and in equity be a perpetual bar to the legal and equitable right, title and interest of the said Harvey, Whitney and Groves, and of all persons, claiming or to claim, by, through or under them, or either of them, in the mortgaged premises or any part thereof.

Provided, however, that until default in the payment of the said sum or interest, or other default, as herein provided, the said Boston Wharf Company, its successors or assigns, shall have no right to enter and take possession of the premises.

In witness whereof, we, the said Harvey, Whitney and Groves, together with Elizabeth F., wife of the said Harvey, Laurinda C., wife of the said Whitney, and Lucy R., wife of the said Groves, in token of their release of all right or title to dower in the granted premises, have hereto set our hands and seals this twentieth day of November, in the year eighteen hundred and sixty-eight.

PETER HARVEY. [SEAL.]

ELIZABETH F. HARVEY. [SEAL.]

JAMES S. WHITNEY. [SEAL.]

LAURINDA C. WHITNEY. [SEAL.]

HENRY B. GROVES. [SEAL.]

LUCY R. GROVES. [SEAL.]

In presence of SAM. W. BATES.

CAROLINE ROBERTS.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK, SS., BOSTON, July 24, A. D. 1869. Personally appeared the above named Harvey, Whitney and Groves, and severally acknowledged the foregoing instrument by them subscribed to be their free act and deed.

Before me,

SAM. W. BATES, *Justice of the Peace.*

AGREEMENT BETWEEN THE BOSTON WHARF COMPANY AND THE BOSTON, HARTFORD AND ERIE RAILROAD COMPANY.

It is hereby agreed, by and between the Boston Wharf Company and the Boston, Hartford and Erie Railroad Company as follows, to wit: Whereas, the said Boston, Hartford and Erie Railroad Company have this day made and delivered to the said Boston Wharf Company their promissory note, dated November 20, 1868, for the sum of one hundred and fifty thousand dollars, payable to the Boston Wharf Company, or order, in six years from date, with interest after three years, payable half-yearly, at the rate of seven per cent. per annum: And whereas, the payment of said note and interest is secured by a mortgage made, at the request of said Boston, Hartford and Erie Railroad Company by Peter Harvey, James S. Whitney and Henry B. Groves, to the said Boston Wharf Company, of that part of the real estate, land and flats at South Boston conveyed by the said Boston Wharf Company to the said Harvey, Whitney and Groves which lies south of the "Commissioners' line A of solid filling:" And whereas, both the said note and the said mortgage to the Boston Wharf Company are intended by the parties hereto as a guarantee and security that the said railroad company will build, or procure to be built and opened for public travel as a highway, an avenue and a bridge across Fort Point Channel, and a public street connecting the real estate and premises described in said mortgage at some point south of the "Commissioners' line A of solid filling," with Federal Street in the city proper, within six years from the twentieth day of November, 1868, without default; and that the said sum of one hundred and fifty thousand dollars and interest shall be paid to the said Boston Wharf Company and retained by them in case the said avenue, bridge and street are not finished, as aforesaid, within the six years, as liquidated and ascertained damages on account of the failure of the said railroad company to construct the said avenue, bridge and street within the time specified: Now, therefore, in consideration of the premises, the said Boston Wharf Company agree with the said Boston, Hartford and Erie Railroad Company that, if a suitable and sufficient bridge and avenue shall, without cost or charge or damage to the said Boston Wharf Company, be located, built and opened to the said Boston Wharf Company, and to the public, for travel as a high-

way (said avenue to be not less than sixty-six feet in width on the eastern side of Fort Point Channel) from the mortgaged premises to Federal Street across Fort Point Channel and across the mortgaged premises, from east to west, south of the "Commissioners' line A of solid filling," within six years from the twentieth day of November, A. D. 1868, the principal of the said note of one hundred and fifty thousand dollars secured by said mortgage shall be deemed to be paid at the time when said avenue and bridge shall be opened for public travel, as aforesaid, and interest thereon shall then cease, and, upon payment of interest that may have before accrued thereon, if any, without default, the said note shall be surrendered to the Boston, Hartford and Erie Railroad Company, and the said mortgage shall be discharged by the said Boston Wharf Company.

In witness whereof, the said Boston Wharf Company and the said Boston, Hartford and Erie Railroad Company have hereto set their respective seals and caused these presents to be executed by their officers thereunto duly authorized, this twentieth day of November, in the year eighteen hundred and sixty-eight.

BOSTON WHARF COMPANY,

By JACOB SLEEPER, *President*. [SEAL.]

BOSTON, HARTFORD & ERIE RAILROAD COMPANY,

By JOHN S. ELDRIDGE, *President*. [SEAL.]

In presence of SAM. W. BATES, the word "nine" on this page being first erased and "eight" inserted.

MORTGAGE OF HARVEY AND OTHERS, TRUSTEES, TO
PIERCE AND OTHERS, TRUSTEES.

An indenture of three parts, made this twentieth day of November, in the year eighteen hundred and sixty-eight, by and between Peter Harvey, of Boston, in the county of Suffolk, James S. Whitney, of Brookline, in the county of Norfolk, and Henry B. Groves, of Salem, in the county of Essex, all in the Commonwealth of Massachusetts, party of the first part, Jacob W. Pierce, of said Brookline, Elisha Atkins, of said Boston, and William Morton, of Newton, in the county of Middlesex, all in the Commonwealth aforesaid, party of the second part, and the Boston, Hartford and Erie Railroad Company, a corporation duly established under and by virtue of the laws of the Commonwealth of Massachusetts, and the States of Rhode Island, Connecticut and New York, and having its principal offices and place of business in Boston, in the county of Suffolk, in the Commonwealth aforesaid, party of the third part:

Whereas, in pursuance of an agreement this day made with the above-named Boston, Hartford and Erie Railroad Company, the Boston Wharf Company, by deed duly executed and to be delivered simultaneously with the execution and delivery of this indenture, has, at the request and for the benefit of the said Boston, Hartford and Erie Railroad Company, sold and conveyed to the above named party of the first part, a certain tract of land and flats hereinafter described, and situate in that part of Boston called South Boston, in said Commonwealth, for the consideration of one million three hundred and fifty thousand dollars (\$1,350,000).

And whereas, one hundred and fifty thousand dollars (\$150,000) of the said consideration is paid in a promissory note for that amount, payable to the said Boston Wharf Company, or order, in six years from date, with interest after three years at the rate of seven per cent. per annum, payable half-yearly, secured by a first mortgage to the said Boston Wharf Company upon that part of the granted premises which lies south of the Commissioners' line A of solid filling, so called.

And whereas, the remaining twelve hundred thousand dollars (\$1,200,000) of the consideration aforesaid is to be received by the said wharf company in the bonds of the said railroad company, payable to the said Boston Wharf Company or bearer, in twenty years from date, with interest at the rate of seven per cent. per

annum, payable semi-annually, by interest coupons attached to said bonds, and the said bonds are to be secured by mortgage of the premises to the party above-named of the second part, subject, however, to the first mortgage above-mentioned upon a part of the premises, to secure the payment of one hundred and fifty thousand dollars (\$150,000) to the Boston Wharf Company.

Now, therefore, this indenture witnesseth, that in consideration of the premises, and of one dollar to them paid, the receipt of which is hereby acknowledged, the said Peter Harvey, James S. Whitney and Henry B. Groves, the party of the first part, do hereby grant, bargain, sell and convey unto the said Jacob W. Pierce, Elisha Atkins and William Morton, the party of the second part, as joint tenants, and to the survivor or survivors of them, and their successor or successors, to be appointed as hereinafter set forth and agreed, and to the heirs and assigns of them, and each of them, forever, a certain parcel of land and flats, situate in that part of said Boston called South Boston, and bounded and described as follows, to wit: beginning at the south-easterly corner thereof, where the same adjoins the flats formerly sold by the said Boston Wharf Company to Samuel Downer, and marked A on the plan recorded herewith; thence running westerly and bounded southerly by said Downer's land and flats, about one hundred and twenty-three feet, to a point marked B on said plan, at the bottom of the sea-wall; then turning and running northerly by the base of the sea-wall about two hundred and sixty feet to the north end of said sea-wall; then running northerly, and a little more westerly, by a line parallel to A Street, and distant two hundred and sixty-three and twenty-six one-hundredths feet easterly from the easterly line of said A Street to a point marked D on the plan aforesaid, in the northerly limit or line of the Boston Wharf Company's territory, as fixed and determined by the statute of the Commonwealth aforesaid, passed in the year eighteen hundred and fifty-two; then turning and running westerly, parallel with West Broadway, about two hundred and ninety-three and seventy-nine one-hundredths feet, to a point marked E on the aforesaid plan, at the centre of A Street extended; then turning and running northerly by the centre of A Street extended to a point marked F on said plan, in the centre of a street shown on said plan, but not named; then turning and running westerly by and through the centre of said last mentioned street to a point on Fort Point Channel marked G on said plan; then turning and running northerly by Fort Point Channel to a point marked H on said plan, in the Commissioners' line B of any structure, as established by statute of the Commonwealth aforesaid, or as far

northerly as the party of the first part have a right to go under their deed from the Boston Wharf Company; then turning and running easterly on the said Commissioners' line B, or by the northerly boundary of land of the grantors, lately owned by the Boston Wharf Company, to the point marked I on said plan, or as far as land and flats lately owned by the said wharf company extend; then turning and running southerly by the easterly boundary of the land and flats lately owned by said Boston Wharf Company, by two lines, to the point A on said plan, at the place of beginning, containing by estimation about two million six hundred thousand square feet of land and flats, and being the same estate and premises conveyed by the said Boston Wharf Company to the said party of the first part by deed of even date herewith, and herewith to be recorded: subject, nevertheless, to the right of way, reserved by the said Boston Wharf Company in their deed aforesaid, across that portion of the said granted land and flats, over which the Boston, Hartford and Erie Railroad is located and built, not exceeding twenty-six feet in width; and subject also to the right of way, and of passing and repassing, reserved by the said Boston Wharf Company for the use and benefit of said wharf company, its agents and servants, its successors and assigns, through and over that part of the granted premises embraced within the lines of Granite Street extended, or to be extended, northwardly to the Eastern Avenue so called, as located, or to such other avenue as shall be built instead of said Eastern Avenue, across Fort Point Channel, to connect the premises conveyed by the said Boston Wharf Company to the said parties of the first part with the city proper, and also through and over the said Eastern or other avenue, if located and built upon, and over any part of said granted premises, and wherever built: and subject, also, to the mortgage made this day by the said party of the first part to the said Boston Wharf Company, of all that part of the described premises which lies south of the "Commissioners' line A of solid filling," to secure payment of one hundred and fifty thousand dollars to the said Boston Wharf Company, and herewith to be recorded, together with the right to lay vessels, and receive wharfage and dockage therefor, on the westerly side of the granted premises in and near Fort Point Channel, and on the northerly and easterly sides of the said premises, so long as the flats adjoining shall remain unfilled.

To have and to hold the afore-granted premises with all the rights, easements, privileges and appurtenances to the same belonging, or in any wise appertaining to the said Pierce, Atkins and Morton, the party of the second part, as joint tenants, and to the survivor or

survivors, of them and their successor or successors, to be appointed as herein after set forth and agreed, and to the heirs and assigns of them and each of them, for their own use and behoof forever.

And we the said Harvey, Whitney and Groves, the party of the first part, for ourselves and our heirs, executors and administrators, do covenant with the said Pierce, Atkins and Morton, the party of the second part, and the survivor and survivors, successor and successors, and their heirs and assigns, that the above-granted premises are free from all incumbrances made by us, except as herein before stated, and that we will and our heirs, executors, and administrators, shall warrant and defend the same to the said party of the second part, their survivor or survivors, successor or successors, and their heirs and assigns forever, against the lawful claims and demands of all persons claiming or to claim, by, through or under us, excepting only those claiming, or to claim under and by virtue of the mortgage herein before referred to.

Provided, however, that if the said Harvey, Whitney and Groves, the party of the first part, or the said Boston, Hartford and Erie Railroad Company, party of the third part, shall pay or cause to be paid, unto the said Pierce, Atkins and Morton, the party of the second part, or the survivor or survivors of them or their successor or successors, or their executors, administrators or assigns, or to the holders of the afore-mentioned bonds of the Boston, Hartford and Erie Railroad Company, the sum of twelve hundred thousand dollars (\$1,200,000) in twenty years from the day of the date hereof, according to the tenor of said bonds, with interest thereon, at the rate of seven per cent. per annum, payable half yearly to the holders of said bonds, as the interest coupons shall become due, and until such payment shall pay all taxes, all water rates and charges for improvements or betterments, for sewers, for making, paving or opening streets, and all assessments of any kind whatever, municipal, state or national, levied or assessed upon, or in respect of the mortgaged premises, or any part thereof, then this deed as also the said bonds made by the Boston, Hartford and Erie Railroad Company, bearing even date with these presents, and numbered from 1 to 1,000 inclusive, for one thousand dollars (\$1,000) each, and from 1,001 to 2,000 inclusive, for two hundred dollars (\$200) each, with interest coupons attached, whereby for value received, the said Boston, Hartford and Erie Railroad Company, promises to pay to the Boston Wharf Company or bearer, the said sum and interest at the times aforesaid, shall all be absolutely void to all intents and purposes.

And *provided, also*, that if default shall be made in the payment of the principal sum due and payable on said bonds, or of the in-

terest accruing thereon, or of any part thereof, or of the taxes, assessments or charges above referred to, and if any such default shall continue for thirty days after demand shall have been made for payment of the amount due on said bonds, or of the interest thereon or of any part thereof, by the parties entitled thereto, or for six months in the payment of the taxes, assessments or charges aforementioned, then, and in either of said events, it shall be lawful for the said Pierce, Atkins and Morton, the party of the second part, the survivor or survivors of them, or their successor or successors or assigns, to sell and dispose of the granted premises, with all the improvements that may be thereon, at public auction, such sale to be upon the premises hereby granted, without further notice or demand, except giving notice of the time and place of sale, by advertising twice in each of three successive weeks in three daily newspapers printed in the city of Boston aforesaid, and the said Pierce, Atkins and Morton, the party of the second part, the survivor or survivors, and the successor or successors of them or their assigns, in their own names, or as the attorneys of the said Harvey, Whitney and Groves, the party of the first part, and of the said Boston, Hartford and Erie Railroad Company, the party of the third part, for that purpose by these presents duly authorized and empowered, may convey the same absolutely and in fee simple to the purchaser or purchasers accordingly; and out of the proceeds and money arising from such sale, may retain all sums then secured by this deed, whether then or thereafter payable, together with interest and all costs and expenses, including all sums paid or to be paid by the grantees, as, and for taxes or assessments or levies of any kind above referred to, and shall pay the surplus if any, to the said Harvey, Whitney and Groves, the party of the first part, or their personal representatives or assigns, or to the court ordering or confirming such sale: and such sale shall forever bar the said Harvey, Whitney and Groves, the party of the first part, and the said Boston, Hartford and Erie Railroad Company, and each and all of them, and all persons or corporations claiming under and through them or either of them, from all right and interest in the premises or any part thereof, at law or in equity.

And it is further agreed by the said parties hereto, that the said party of the second part, their survivors or successors or assigns, may purchase at the said sale, and that no other purchaser shall be answerable for the application of the purchase money.

And it is further agreed by all parties hereto, without prejudice to the power of sale herein before provided for, and in addition thereto, that in case of default in the payment of the aforesaid sum,

or of the bonds aforesaid, or of the interest or taxes or other assessments, in manner and form as aforesaid, at the election of the said parties of the second part, their survivors or successors or assigns, an entry may be made by them and possession may be taken of the mortgaged estate and property, for foreclosure of this mortgage, which being continued for three years from and after such entry shall forever at law and in equity be a perpetual bar to the legal and equitable title and interest of the said mortgagors, and of the said railroad company, and of all persons claiming or to claim, by, through or under them, or either of them in the mortgaged premises, or any part thereof.

Provided, however, that until default in the payment of the said sum or interest, or of some part thereof, or other default as herein provided, the said party of the second part, their survivor or survivors or successors or assigns, shall have no right to enter and take possession of the granted premises.

And it is hereby further stipulated and agreed that if, at any time before any default in the payment of the principal or interest of said bonds, or of the taxes and assessments before mentioned, the said party of the first part or the said railroad company shall sell to any person other than said railroad company any part or parts of the estate and property mortgaged less than the whole; they shall have the right to do so, from time to time, upon cancelling and putting cancelled into the hands of the said party of the second part, or their representatives or assigns, such amount of said bonds as in the opinion of the said party of the second part, or of those holding their estate in the premises, shall, at their par value, be equal at least to the value of the land sold, and also shall leave the outstanding bonds well and properly secured. And the said parties of the first part may also have a like privilege of selling, from time to time, portions of the mortgaged premises, provided that they shall pay over to the said trustees an amount not less than the value of the land sold, either in a good and satisfactory note or notes, secured by mortgage on the land sold, or in registered bonds or securities of the United States, or of the Commonwealth of Massachusetts, or of the City of Boston, and an additional sum, if, in the opinion of said trustees, it shall be required to constitute, with the land not sold and not to be released, ample and satisfactory security for the prompt and full payment of the outstanding bonds and of all interest accrued or to accrue thereon, when due, and such notes and mortgages, stocks and bonds so received, with the consent of the trustees, shall never exceed in amount the sum of three hundred thousand dollars (\$300,000) at one time, and

may, if said trustees assent thereto, be exchanged by the said parties of the first part for cancelled bonds issued as herein before provided to the Boston Wharf Company, at such rates and in such amounts as the trustees shall see fit, provided they shall not thereby lessen or impair the security of the remaining outstanding uncanceled bonds. And the notes and mortgages, stocks and bonds received for sales by said trustees shall be, unless before exchanged, as herein before provided, held and kept safely by said trustees until the maturity of the bonds issued by said railroad company to the Boston Wharf Company or until default in payment of the interest thereon, and shall then be sold by the said trustees and the proceeds applied to the payment of the said bonds and accrued interest and expenses in the same way as if the land mortgaged had been, under the power herein given to said trustees, sold in case of default in payment of principal or interest on said bonds or other default, herein before provided against, unless the principal of said bonds and the interest and all taxes, assessments, charges and expenses shall be paid at maturity and when due by the said railroad company, and, in that case, the trustees shall return to the said parties of the first part, or their representatives, the stocks and bonds, notes and mortgages deposited with them.

And it is further provided that the said trustees shall collect and receive the income and interest accruing on the securities deposited with them, as aforesaid, and, if the said railroad company shall promptly and fully pay the accruing interest on their bonds, the said trustees may pay over such income and interest received by them to the parties from whom the securities were received. And it is further provided that the holders of the bonds shall not be responsible, in any way, nor shall they suffer by losses and expenses growing out of the depreciation or the management by said trustees, of the said deposited securities; nor shall the said trustees be answerable to the said parties of the first part, or their representatives jointly, or one for another, for any loss or mismanagement of said deposited securities, except such as may arise from gross negligence or fraud, or other misfeasance, in which all have participated, but each trustee shall be answerable to the said parties of the first part for his own personal neglect or default only, and for such sums only as may have come into his own hands or control.

And upon the receipt of the aforesaid cancelled bonds, notes and mortgages, or other securities above referred to, satisfactory to the said trustees, the parties of the second part, as herein before provided in case of sales, the said trustees shall, from time to time, as required, release and discharge from this mortgage the lands so sold,

provided that all the expenses and charges of the said trustees for services relating thereto shall first be paid by the said party of the first part, or their representatives or assigns.

And we, the said Pierce, Atkins and Morton, the party of the second part, do hereby acknowledge and declare that the foregoing deed of mortgage is made to us, and we receive and agree to hold and deal with the same and the estate and property therein described and conveyed, for the security of the holders of the bonds herein before mentioned, issued, or to be issued, by the Boston, Hartford and Erie Railroad Company, numbered, as aforesaid, from 1 to 1,000 of one thousand dollars each, and from 1,001 to 2,000 inclusive, of two hundred dollars each, and each bond is to be certified by an endorsement of our signatures upon it before delivery thereof to the Boston Wharf Company, and the mortgage to be duly stamped, as required by law.

And we, the said Pierce, Atkins and Morton, the party of the second part, do further declare and agree that we, and our representatives and assigns, will and shall continue to hold the said mortgage and the right and title in and to the mortgaged estate and property thereby conveyed until payment of the principal of the said bonds, and of the interest accrued thereon, shall have been made, according to the tenor of the said bonds, or until, by virtue of the power of sale herein contained, and for default of payment of interest or principal of said bonds, or other default, as herein before provided, we, or our successors in said trust, shall have sold and conveyed the mortgaged estate and property, or shall have foreclosed the said mortgage upon the premises conveyed, or shall have released the same in part in the manner and for the purposes herein and hereby set forth and provided.

And we further covenant and agree that we, and our successors and assigns, upon the occurrence of any default in payment of the interest or principal of the said bonds as the same may become due and payable, or of the taxes and assessments before mentioned, and as soon thereafter as we shall be requested, in writing, by a majority of the holders of said bonds or by the holders of one half in amount thereof, or before such request, if, in our judgment, the interest of the bondholders will be promoted thereby, will and shall sell and convey the mortgaged estate and property, in the way and manner herein before provided, for the benefit of said bondholders, and will pay the amount received and legally to be retained by us from said sale or sales, after payment of the proper and legal charges and expenses, without unnecessary delay, to and among the bondholders in proportion to their several and respective interests or ownership

thereof; and, in case the proceeds of such sale or sales shall not be sufficient to pay in full the principal and interest due on said bonds, will pay first the accrued interest in full, and thereafter an equal percentage or proportion of the principal of said bonds remaining unpaid to and among all the holders thereof, or upon a like request, in writing, of the bondholders, or without such request, if we deem it essential to their interest, we will after default, as aforesaid, enter upon and take and hold possession of said mortgaged estate and property, or of so much thereof as shall not have been released for foreclosure of the mortgage thereon.

And it is hereby agreed by all the parties hereto that, in case of the death, resignation, inability or removal of one or more of the parties of the second part, trustees, as herein before declared, the estate and property herein conveyed, and the trusts hereby created and declared, shall vest in the remaining trustee or trustees until there shall be a new trustee or trustees appointed as hereinafter specified, or otherwise, according to law; and the vacancy or vacancies occurring, as aforesaid, shall be filled, without unnecessary delay, by the remaining trustee or trustees by appointment from among the bondholders; and such new appointment shall be certified by the trustee or trustees making it, and the acceptance of the trust by the person or persons appointed shall be signified in writing, both to be endorsed on this deed, or a duplicate thereof, and the trustee or trustees so appointed and accepting shall become vested with all the authority, power and duties, and with all the right, title and interest, herein conveyed to and incumbent on the the said Pierce, Atkins and Morton, the party of the second part herein named.

And the said Pierce, Atkins and Morton, the party of the second part, do hereby covenant and agree, each for himself, and not for the others, that, in case of resignation, removal or decease, he will, or his heirs or personal representatives shall, make, execute and deliver any and all reasonable and proper conveyances, transfers or assurances in the law needful and proper to transfer and vest the estate, right, title and authority herein and hereby conveyed to and vested in the said Pierce, Atkins and Morton, the party of the second part herein named, and in each of them, in and to his and their successors in the said trust, as may be advised or required by counsel learned in the law, for the security and benefit of the holders of the bonds aforesaid. And the said Boston, Hartford and Erie Railroad Company, the party of the third part, doth hereby assent and agree to, and ratify and confirm, the conveyance and the agreements and stipulations made and entered into as herein before set

forth by the parties hereto; and further covenants with the said party of the second part that the said party of the first part has good right to make and enter into the same, and will duly observe and carry out the same, for the intents and purposes stated and recited in this indenture; and also, that all the reasonable expenses and charges of the trustees for services in regard to the trust herein created and declared, and in the management of the trust estate and property shall be paid to them by the said railroad company.

In witness whereof, the said Harvey, Whitney and Groves, the party of the first part, together with Elizabeth F., wife of the said Harvey, Laurinda C., wife of the said Whitney, and Lucy R., wife of the said Groves, in token of their release of all right or title to dower in the granted premises, and the said Pierce, Atkins and Morton, the party of the second part, have hereto, and to duplicates hereof, set their hands and seals, and the said Boston, Hartford and Erie Railroad Company, party of the third part, has hereto, and to duplicates hereof, set its corporate seal, and caused the same to be subscribed by the president thereof, thereto duly authorized, on the day and year first above stated.

HENRY B. GROVES.

[SEAL.]

LUCY R. GROVES.

[SEAL.]

JAMES S. WHITNEY.

[SEAL.]

LAURINDA C. WHITNEY.

[SEAL.]

PETER HARVEY.

[SEAL.]

ELIZABETH F. HARVEY.

[SEAL.]

JACOB W. PIERCE.

[SEAL.]

ELISHA ATKINS.

[SEAL.]

WM. MORTON.

[SEAL.]

BOSTON, HARTFORD & ERIE R. R. CO.,
By JOHN S. ELDRIDGE, *President*.

[SEAL.]

In presence of

CAROLINE ROBERTS.

SAM. W. BATES.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK SS., BOSTON, July 24, A. D. 1869. Personally appeared the above-named Groves, Whitney, Harvey, Pierce, Atkins and Morton, and severally acknowledged the foregoing instrument by them subscribed, to be their free act and deed. Before me,

SAM. W. BATES, *Justice of the Peace*.

At a meeting of the stockholders in the Boston, Hartford and Erie Railroad Company, duly called and held at Boston, the 24th day of July, A. D. 1869, it was voted unanimously,

That the statute of the Commonwealth of Massachusetts passed June 23, 1869, being chapter four hundred and fifty-six of the acts of the year 1869, be, and the same is hereby, accepted by this corporation; and the president of this company is hereby authorized and instructed to execute and deliver to the Boston Wharf Company, bonds of this corporation to the full amount of twelve hundred thousand dollars, of the tenor and date specified in said Act; one thousand of said bonds being for the sum of one thousand dollars and interest each, and one thousand of said bonds being additional, numbered from 1,001 to 2,000 inclusive, being for the sum of two hundred dollars and interest each; the said bonds so executed to be delivered in consideration of the conveyance by said Boston Wharf Company to Peter Harvey, James S. Whitney and Henry B. Groves, of certain lands and flats at South Boston, purchased by and for the use of this corporation, and the payment of said bonds is to be secured by a mortgage to Jacob W. Pierce, Elisha Atkins and William Morton, trustees for the holders of said bonds, to be made and delivered to said Pierce, Atkins and Morton, trustees, simultaneously with the delivery of the deed from the Boston Wharf Company, both bearing date November 20, 1868, and hereafter to be delivered; and the president of this corporation is also authorized and instructed to execute, acknowledge and deliver, in behalf of this corporation, the aforesaid mortgage to said Pierce and others, trustees, and also to execute, acknowledge and deliver, in behalf of this corporation, a mortgage dated November 20, 1868, to the said Boston Wharf Company, to secure payment of the promissory note of this corporation for the sum of one hundred and fifty thousand dollars, payable in six years from November 20, 1868, to said Boston Wharf Company or order, with interest after three years; and also an agreement of even date with the said Boston Wharf Company as to the payment of said note; and also to execute, acknowledge and deliver in behalf of this corporation, an indenture of two parts, dated July 21, 1869, concerning the enclosure and improvement of the flats mortgaged to Pierce and others, and the Boston Wharf Company, in case the mortgagees shall come into possession for breach of the conditions of the said mortgages, or either of them. And also to execute, acknowledge and deliver, in behalf of this corporation, the following described instruments, all dated July 21, 1869, to wit: 1. An indenture of five

parts made by and between the Commonwealth, acting by its Board of Harbor Commissioners, and by Peter Harvey, James S. Whitney and Henry B. Groves, and by Jacob W. Pierce, Elisha Atkins and William Morton, trustees, and by the Boston, Hartford and Erie Railroad Company, and by the Boston Wharf Company. 2. An agreement between said Commonwealth and this corporation relating to the improvement of certain flats in South Boston and other matters. And 3, a mortgage by this corporation and the aforesaid Harvey, Whitney and Groves to the said Commonwealth, to secure payment of \$545,505.00, and for other purposes; and that said Harvey, Whitney and Groves, trustees for the Boston, Hartford and Erie Railroad Company, be, and they are hereby instructed and authorized, to execute and deliver said indenture of five parts, and said mortgage, to the Commonwealth for security of said \$545,505.00, and other purposes, of date of July 21, 1869.

A true copy, exemplified from the original records this 24th day of July, A. D. 1869.

Attest:

THOMAS E. GRAVES, *Secretary pro tem.*

AGREEMENT BETWEEN THE COMMONWEALTH OF MASSACHUSETTS AND THE BOSTON WHARF COMPANY, AND ITS TRUSTEES, THE BOSTON, HARTFORD AND ERIE RAILROAD COMPANY, AND ITS TRUSTEES.

Memorandum of an agreement made and concluded this twenty-first day of July, *anno Domini*, eighteen hundred and sixty-nine, by and between the Commonwealth of Massachusetts, acting by its Board of Harbor Commissioners of the *first part*: Peter Harvey, of Boston, in Suffolk County, James S. Whitney, of Brookline, in Norfolk County, and Henry B. Groves, of Salem, in the County of Essex, trustees in behalf of the Boston, Hartford and Erie Railroad Company, as hereinafter declared, parties of the *second part*: the Boston, Hartford and Erie Railroad Company, a corporation established by the laws and authority of the States of Connecticut, Rhode Island, New York and Massachusetts, party of the *third part*: Jacob W. Pierce, of Brookline, in the County of Norfolk, and Elisha Atkins of Boston, in the County of Suffolk, and William Morton, of Newton, in Middlesex County, trustees in behalf of the holders of twelve hundred thousand dollars of bonds, issued by the Boston, Hartford and Erie Railroad Company, party of the *fourth part*: and the Boston Wharf Company aforesaid, party of the *fifth part*.

Witnesseth: In consideration of the agreements hereinafter set forth, the Commonwealth of Massachusetts hereby releases and quits to said Peter Harvey, James S. Whitney and Henry B. Groves, trustees, at the request and for the benefit of said Boston, Hartford and Erie Railroad Company, and as mortgagors to said Jacob W. Pierce, Elisha Atkins and William Morton, mortgagees and trustees for the holders of bonds of said Boston, Hartford and Erie Railroad Company in the principal sum, in the whole, of twelve hundred thousand dollars, issued under a mortgage deed, dated November 20, 1868, all its right, title and interest, in and to a parcel of flats situated in Boston, in that part thereof known as South Boston, bounded and described as follows, to wit: Commencing on the Commissioners' line on the easterly side of Fort Point Channel, established by chapter 35, of the Acts of the year 1840, at a point marked X, on the annexed plan marked II, three hundred and twelve and a half ($312\frac{1}{2}$) feet southerly from the intersection of the Commissioners' line B, established by chapter

385, of the Acts of the year 1853, with said Commissioners' line on the easterly side of Fort Point Channel, and thence running southerly on said last named Commissioners' line, to Commissioners' line A, established by chapter 385 of the Acts of the year 1853, to a point marked K; thence easterly on said Commissioners' line A, a distance of one thousand and ninety-three (1,093) feet, to a point marked L, on said plan; thence running northerly in a straight line eight hundred and fifty-eight (858) feet, to a point marked Z, on said plan, distant one thousand and ninety-three (1,093) feet easterly, from the point of beginning on the said Commissioners' line on the easterly side of Fort Point Channel, marked X, on said plan, and thence running westerly from said point Z, in a straight line, a distance of one thousand and ninety-three (1,093) feet, to the point of beginning, as shown on the annexed plan marked H. The said Commonwealth, however, reserving the right that no drains or sewers shall be laid or built upon, or in said released premises, except in accordance with plans approved by the Board of Harbor Commissioners. To have and to hold the same to said grantees, the survivors and survivor of them, their heirs and assigns as trustees, for the benefit of the Boston, Hartford and Erie Railroad Company, and as mortgagors to said Jacob W. Pierce, Elisha Atkins and William Morton, mortgagees and trustees, for the holders of the bonds of said Boston, Hartford and Erie Railroad Company, under mortgage deed, of date of November 20, 1868, as aforesaid, to their use and behoof forever: and said Commonwealth hereby authorizes and empowers said Jacob W. Pierce, Elisha Atkins and William Morton, mortgagees and trustees, as aforesaid, and their heirs and assigns, to build on and within the westerly boundary of said territory, herein released and quitclaimed to them by the Commonwealth, a wall and platform, with suitable opening or openings therein, for a dock or docks, in accordance with a plan of a wall and platform signed by the Harbor Commissioners of said Commonwealth, and approved by the governor and council, and marked G, and hereto annexed, and to dredge the flats lying in the section of Fort Point Channel, opposite the said territory, uniformly to the thread of said channel, to the depth of twelve (12) feet, at mean low-water, with suitable berths for vessels, and to fill said territory solid to the grade of sixteen (16); and may also construct and maintain suitable bulkheads on the north and east lines of said released premises, to retain the filling that may be put thereon, but only in case they shall take possession of the territory or some part thereof, herein released by the Commonwealth, and hold the same, or shall sell the same or some part thereof, under said mort-

gage to them, executed by said Harvey, Whitney and Groves; provided that the right to lay vessels in front of the released premises in said Fort Point Channel, and to take wharfage and dockage therefor, shall terminate whenever, if at all, said channel shall cease to be open for the purposes of navigation by authority of the legislature, but this provision shall not be held or construed to imply any opinion in favor of such legislation. Said Peter Harvey, James S. Whitney and Henry B. Groves, parties of the second part, grantees by a conveyance of November 20, 1868, from said Boston Wharf Company, and trustees, for the benefit of said Boston, Hartford and Erie Railroad Company, of the flats in this article hereinafter described; and said Boston, Hartford and Erie Railroad Company, party of the third part, by its president, John S. Eldridge, fully authorized, it being *cestuy que trust* of said flats, held by said Harvey, Whitney and Groves, by and under said conveyance from said Boston Wharf Company; and said Jacob W. Pierce, Elisha Atkins and William Morton, parties of the fourth part, trustees under the mortgage of November 20, 1868, from said Peter Harvey, James S. Whitney and Henry B. Groves, of the flats in this article set forth, to secure the payment to the holders of the bonds issued by said Boston, Hartford and Erie Railroad Company, to the amount of twelve hundred thousand dollars, as above recited; and said Boston Wharf Company, party of the fifth part, by Jacob Sleeper, its president, thereto fully authorized, it being *cestuy que trust* in said flats mortgaged to said Pierce, Atkins and Morton, and the present holder of all said bonds issued by said Boston, Hartford and Erie Railroad Company, under said mortgage (to all which said deeds of conveyance and mortgage, to be recorded with this instrument, reference is hereby made) in consideration of the agreements herein set forth, said parties of the second, third, fourth and fifth parts, hereby release and quitclaim to said Commonwealth of Massachusetts, and to its assigns forever, all the right, title and interest, they and any of them have or has, in and to a parcel of land and flats, situated in said South Boston, bounded and described as follows, to wit: Commencing on the Commissioners' line, on the easterly side of Fort Point Channel, established by chapter 35, of the Acts of the year 1840, at a point marked X, on the annexed plan marked H, three hundred and twelve and a half (312½) feet, southerly from the intersection of said Commissioners' line B, with said Commissioners' line on the easterly side of Fort Point Channel; thence running easterly in a straight line, one thousand and ninety-three (1,093) feet, to a point marked Z, on said plan, eight hundred and fifty-eight (858) feet, northerly from a point marked L, on said

plan in Commissioners' line A, distant easterly from the Commissioners' line on the easterly side of Fort Point Channel, one thousand and ninety-three (1,093) feet; thence from said point Z, southerly in a straight line to said point marked L, on said plan; thence easterly on said Commissioners' line A, to the line settled by the supreme judicial court, under chapter 455, of the Acts of the year 1855, as the easterly boundary line of the flats embraced by the provisions of said Act, at a point marked M, on said plan; thence northerly on the said easterly boundary line of said flats, described in said Act of 1855, to said Commissioners' line B, at a point marked N, on said plan; thence westerly on said Commissioners' line B, to said Commissioners' line on the easterly side of Fort Point Channel, at a point marked P, on said plan; thence southerly on said Commissioners' line on the easterly side of Fort Point Channel, to the point of beginning marked X, as shown on the annexed plan marked H.

To have and to hold the same to said Commonwealth and its assigns, to its and their own use and behoof forever.

Said parties of the second, third, fourth and fifth parts, for the consideration aforesaid, hereby release and quitclaim to said Commonwealth, all the right they and any of them have or has to lay vessels on the northerly and westerly end and side of the territory released to said Commonwealth in the second foregoing section and on the easterly bounds of flats or territory of said parties and either of them lying between Fort Point Channel and the line of B Street extended, and all right to receive wharfage and dockage therefor, and all the right of said parties and each of them to the flats northerly of said Commissioners' line B, and all the rights, if any, they or any of them have to keep the flats lying northerly of said Commissioners' line B, or easterly of any territory, or flats of said parties or either of them lying easterly of Fort Point Channel as far as the line of B Street extended, or any portion of them, flowed by the tide-waters and open to navigation.

To have and to hold the same to said Commonwealth, and its assigns, to its and their use and behoof forever.

In witness whereof, the said Harbor Commissioners, in behalf of said Commonwealth, have hereunto set their hands and seals, and the said Harvey, Whitney, Groves, Pierce, Atkins and Morton have hereto set their hands and seals, and the said Boston, Hartford and Erie Railroad Company hath hereto set its hand and seal by John S. Eldridge, its president, and the said Boston Wharf Company hath hereto set its hand and seal by Jacob Sleeper, its presi-

dent, this twenty-first day of July, in the year of our Lord eighteen hundred and sixty-nine.

JOSIAH QUINCY.	[SEAL.]
S. E. SEWALL.	[SEAL.]
F. W. LINCOLN, JR.	[SEAL.]
DARWIN E. WARE.	[SEAL.]

Harbor Commissioners.

PETER HARVEY.	[SEAL.]
JAMES S. WHITNEY.	[SEAL.]
HENRY B. GROVES.	[SEAL.]
JACOB W. PIERCE.	[SEAL.]
ELISHA ATKINS.	[SEAL.]
WILLIAM MORTON.	[SEAL.]

In presence of HENRY MITCHELL, To H. C.
SAM. W. BATES.

BOSTON, HARTFORD & ERIE R. R. CO.,
By JOHN S. ELDRIDGE, *President*. [SEAL.]

BOSTON WHARF COMPANY,
By JACOB SLEEPER, *President*. [SEAL.]

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK, SS., JULY 24, 1869.—Personally appeared the said Josiah Quincy, Samuel E. Sewall, Frederick W. Lincoln, Junior and Darwin E. Ware, Harbor Commissioners, and acknowledged the foregoing instrument by them subscribed, to be the free act and deed of the Commonwealth of Massachusetts and of themselves in behalf of said Commonwealth; and the said Harvey, Whitney, Groves, Pierce, Atkins and Morton, and acknowledged the foregoing instrument by them signed, to be their free act and deed; and the said Jacob Sleeper, and acknowledged the foregoing instrument to be the free act and deed of the said Boston Wharf Company; and the said John S. Eldridge, and acknowledged the foregoing instrument to be the free act and deed of the said Boston, Hartford and Erie Railroad Company. Before me,

SAM. W. BATES, *Justice of the Peace*.

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER, BOSTON, July 26, 1869.

Approved in Council.

OLIVER WARNER, *Secretary*.

DEED OF THE COMMONWEALTH OF MASSACHUSETTS
TO HARVEY AND OTHERS, TRUSTEES.

Know all men by these presents, That the Commonwealth of Massachusetts, acting by its Board of Harbor Commissioners, in consideration of five hundred and forty-five thousand five hundred and five dollars to it paid, by Peter Harvey, of Boston, in Suffolk County, James S. Whitney, of Brookline, in Norfolk County, and Henry B. Groves, of Salem, in the county of Essex, the receipt of which is hereby acknowledged, does hereby give, grant, bargain, sell and convey unto the said Harvey, Whitney and Groves, a certain parcel of flats situated in that part of Boston called South Boston, and bounded and described as follows, to wit: Commencing at a point marked X on the plan marked C, hereto annexed, on the Commissioners' line on the eastern side of Fort Point Channel, established by chapter 35 of the Acts of the year 1840, three hundred and twelve and a half feet southerly from the intersection of the Commissioners' line B, established by chapter 385 of the Acts of the year 1853, with said Commissioners' line on the easterly side of Fort Point Channel, and running northerly three hundred and twelve and a half feet on the line established by chapter 35 of the Acts of the year 1840, to a point marked P on the annexed plan marked C; thence running on the modified line of 1867, being the exterior line shown on the plan annexed to the second annual report of the Board of Harbor Commissioners, and defined in said report, for a distance of one thousand six hundred and fourteen feet, to a point marked Y on said annexed plan marked C; thence southerly in a straight line to a point marked Z on said annexed plan, which point is one thousand and ninety-three feet easterly in a straight line from the point of beginning, and eight hundred and fifty-eight feet northerly from a point marked L on Commissioners' line A, established by chapter 385 of the Acts of the year 1853, and distant easterly on said line one thousand and ninety-three feet from said Commissioners' line on the easterly side of Fort Point Channel; thence westerly in a straight line a distance of one thousand and ninety-three feet to the point of beginning marked X, according to the plan hereto annexed marked C, and containing by estimation one million ninety-one thousand and ten square feet, together with the right to lay vessels on the northerly and westerly sides of said territory, and to receive wharfage and dockage therefor: *provided, however,* that the right shall terminate as to any

portion of said territory whenever, by authority of the legislature, the channel on which such portion borders shall cease to be open to navigation; but this provision shall not be held or construed to imply any opinion in favor of such legislation: but it is agreed between the parties hereto, that when said territory shall have been filled, as is provided in an agreement of even date herewith between said Commonwealth and the Boston Hartford and Erie Railroad Company, the same shall be surveyed by the engineer of the Harbor Commissioners of said Commonwealth, and the said consideration of five hundred and forty-five thousand five hundred and five dollars shall be increased or diminished at the rate of fifty cents per square foot, according as the number of feet, exclusive of Northern Avenue, shall be found to be more or less than one million ninety-one thousand and ten square feet; and the amount found due to the Commonwealth, if any, shall be paid in cash by said grantees, or their assigns; or in case the said consideration shall be found to be less than five hundred and forty-five thousand five hundred and five dollars, then the amount of such diminution shall be indorsed by the Commonwealth upon the note taken for the purchase money hereof as a partial payment of the same.

And the said Commonwealth reserves to itself in said territory the right, by its Harbor Commissioners, subject to the approval of the Governor and Council, to locate upon, over and across, the said territory, Northern Avenue seventy-five feet in width, substantially as shown on said plan marked C, hereto annexed, and to appropriate and devote the territory embraced within the limits of said avenue, when located, to all the uses and purposes of a public street or highway, without compensation to said Harvey, Whitney or Groves, or their successors or assigns, or any one claiming under them, for the territory so appropriated, or the filling of the same.

To have and to hold the same, with all the privileges and appurtenances thereto belonging, to the said Harvey, Whitney and Groves, their heirs and assigns, and the survivor or survivors of them, his and their heirs and assigns, to their use and behoof forever.

And the said Commonwealth does covenant with the said Harvey, Whitney and Groves, their heirs and assigns, that it is lawfully seized in fee of the afore-granted premises, that they are free from all incumbrances, that it has a good right to sell and convey the same to the said Harvey, Whitney and Groves, their heirs and assigns, forever as aforesaid, and that it will warrant and defend the same to the said Harvey, Whitney and Groves, their heirs and assigns, forever.

In witness whereof, the said Harbor Commissioners, in behalf of said Commonwealth of Massachusetts, have hereunto set their hands and seals, this twenty-first day of July, in the year of our Lord eighteen hundred and sixty-nine.

JOSIAH QUINCY,	[SEAL.]
S. E. SEWALL,	[SEAL.]
F. W. LINCOLN, JR.,	[SEAL.]
DARWIN E. WARE,	[SEAL.]

Harbor Commissioners.

In presence of

HENRY MITCHELL, to H. C.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK SS., JULY 24, 1869. Personally appeared the said Josiah Quincy, Samuel E. Sewall, Frederick W. Lincoln, Junior, and Darwin E. Ware, Harbor Commissioners, and acknowledged the foregoing instrument, by them subscribed, to be the free act and deed of the Commonwealth of Massachusetts, and of themselves on behalf of said Commonwealth. Before me,

SAM. W. BATES, *Justice of the Peace.*

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER, BOSTON, July 26, 1869.

Approved in Council.

OLIVER WARNER, *Secretary.*

AGREEMENT OF THE BOSTON, HARTFORD AND ERIE
RAILROAD COMPANY WITH THE COMMONWEALTH
OF MASSACHUSETTS.

Articles of agreement made this twenty-first day of July, one thousand eight hundred and sixty-nine, by and between the Commonwealth of Massachusetts, party of the first part, acting by its Harbor Commissioners, and the Boston, Hartford and Erie Railroad Company, party of the second part.

Witness: That whereas said Commonwealth has by deed of even date herewith, conveyed to Peter Harvey, James S. Whitney and Henry B. Groves, trustees for said railroad company, under declaration of trust, dated July 21, 1869, and to be recorded in Suffolk Registry of Deeds, certain flats owned by said Commonwealth, and bounded as follows:—Commencing at a point marked X, on the plan marked C, hereto annexed, on the Commissioner's line on the eastern side of Fort Point Channel, established by chapter 35 of the Acts of the year 1840, three hundred and twelve and a half feet southerly from the intersection of the Commissioners' line B, established by chapter 385, of the Acts of the year 1853, with said Commissioners' line on the easterly side of Fort Point Channel, and running northerly three hundred and twelve and a half feet on the line established by chapter 35 of the Acts of the year 1840, to a point marked P, on the annexed plan marked C; thence running on the modified line of 1867, being the exterior line shown on the plan annexed to the second annual report of the Board of Harbor Commissioners and defined in said report, for a distance of one thousand six hundred and fourteen feet to a point marked Y, on said annexed plan marked C; thence southerly in a straight line, to a point marked Z, on said annexed plan, which point is one thousand and ninety-three feet easterly in a straight line from the point of beginning, and eight hundred and fifty-eight feet northerly from a point marked L, in Commissioners' line A, established by chapter 385 of the Acts of the year 1853, and distant on said line one thousand and ninety-three feet easterly from the said Commissioners' line on the easterly side of Fort Point Channel; thence westerly in a straight line a distance of one thousand and ninety-three feet to the point of beginning marked X, according to the plan hereto annexed, marked C, reserving the right to locate Northern Avenue as therein provided.

Now, therefore, in consideration of the premises, said railroad

company hereby agrees within three years from July 1st, A. D. 1869, to build a wall and platform in accordance with a plan of wall and platform hereto annexed, marked G, from Commissioners' line of 1840, on the easterly side of Fort Point Channel and on the modified line of 1867, to a point three hundred and eighty-seven and a half feet northerly from Commissioners' line B.

The base of said wall shall commence at a point on Commissioners' line A, marked Q, on annexed plan, marked C, twenty-five feet easterly of the said Commissioners' line on the easterly side of Fort Point Channel, established by chapter 35 of the Acts of the year 1840; and thence extending, as shown by the red line on annexed plan marked C, parallel to said Commissioners' line of 1840, and the modified line of 1867, to a point three hundred and eighty-seven and a half feet northerly from Commissioners' line B.

Said wall shall be built in such location as shall be marked out by the Engineer of the Board of Harbor Commissioners, previous to the commencement of operations by said party of the second part, and said party of the second part shall preserve the location of said line by driving piles to mark the location of the wall permanently.

The trench shall be dredged for the wall, under the direction of said Board, to a depth of two feet below low-water spring tides.

The foundation piles to support the wall shall occupy a space nine feet wide, having five piles in parallel rows, said rows to be two and one-half feet distant from centre to centre of each row.

All piles shall be driven into the hard clay stratum to the satisfaction of the Harbor Commissioners. The piles to be in diameter not less than ten inches at low-water mark spring tides, at which point they are to be sawed off level with each other. The two front rows of piles to be driven on a true batter with the face of the wall.

On the top of the piles is to be spiked spruce plank twelve inches wide and three inches thick. The space between the heads of the piles for two feet in depth to be filled and well rammed with stone chip ballast or oyster shells.

The wall from low-water spring tides to the top of the coping stones or grade sixteen, shall be eighteen feet in height, with a true batter front and rear. The wall shall be nine feet wide at the bottom and five feet wide at the top, including an offset of one foot for a resting place for cap to support the ends of platform joists; to be constructed of good quality granite rubble wall stones, with sufficient headers to secure the stability of the wall. Said wall shall be built in all respects, equal, in regard to material and workmanship, to the sea-wall built by the Boston Wharf Company

on the easterly side of Fort Point Channel, between the Boston, Hartford and Erie Railroad bridge, and the Washington Avenue bridge. The rear of the wall shall be ballasted with granite chip ballast stone or oyster shells, from the back of the wall to a line commencing at a point two feet in rear of the back of the top of the wall, and extending in a slope of forty-five degrees to the base of the wall, as shown on annexed plan marked G.

At the end of the wall a flank wall shall be built to connect this wall with the adjoining heavy sea-wall, according to the direction of the Engineer of the Board of Harbor Commissioners.

Said railroad company agrees to commence the work within sixty days after notice that the location of the wall is made, and prosecute the work without delay to its completion, and agrees to complete the wall on or before the first day of July, eighteen hundred and seventy-two.

And said railroad company further agrees to build within said three years, unless for good cause shown, the Harbor Commissioners, with the consent of the governor and council, shall extend said time, a wall commencing at the westerly end of said flank wall and one foot within the said modified line of 1867; and thence extending northerly and easterly, parallel to said modified line, to the easterly boundary of the flats herein before described and conveyed by said Commonwealth to said Harvey, Whitney and Groves.

The said sea-wall shall be built on the above described line, parallel to said modified line, and one foot within the same as aforesaid, as shown by red line on plan C, and in such location as shall be marked out by the Engineer of the Board of Harbor Commissioners, previous to the commencement of operations by said party of the second part, and said party of the second part shall preserve the location of said line by driving piles to mark the location of the wall permanently. The sea-wall shall be built in accordance with the plan marked F, hereto annexed.

The trench for this sea-wall shall be excavated under the direction and to the satisfaction of said Board of Harbor Commissioners, from twenty-three to twenty-five feet in width at the bottom, which shall be as nearly as practicable a level surface. The depth of the trench shall be at least twenty-three feet below mean low-water and always to hard bottom.

The wall to the height of one foot below low-water shall be built in quarry face dimension stone of granite, laid in courses of two feet rise each, by the aid of submarine divers. The courses shall be laid alternately, entirely with headers and stretchers, the bottom or first course being headers. Each stone shall be at least four feet,

and not more than ten feet long, at least eighteen inches wide, and exactly two feet rise.

The wall shall be compactly laid in a substantial and workman-like manner with fair and close outer face. Stones shall be laid so as to break joints everywhere, with good and sufficient bearing upon the beds without pinners.

The front face of the wall shall have a batter of four inches to the foot, and the rear of the wall shall be perpendicular. The base of the wall shall be eighteen feet. The height of the wall to one foot below mean low-water, twenty-two feet, and the thickness of the wall at top, eleven feet four inches.

The wall from one foot below mean low-water to the top of the coping stones, or grade sixteen, shall be laid with dimension stone, in cement. The courses shall be laid with headers and stretchers, and have two feet rise, with the exception of the coping course, which shall have a rise of three feet, and be entirely of headers. The stretchers shall be at least four feet long, and the headers shall not be less than five feet long from face inwardly. The front batter of the face shall be four inches to the foot.

The base of this wall shall be nine feet eight inches; the height seventeen feet, and the thickness at the top of the wall five feet.

The ends of all the sections of the wall shall be faced up in the manner above required.

In consideration of the conveyance by the Commonwealth above referred to, said railroad company hereby agrees, within three years from July first, eighteen hundred and sixty-nine, unless, for good cause shown, the Harbor Commissioners, with the consent of the governor and council, shall extend said time, to fill all said lands and flats herein before described, together with the lands and flats purchased by said Harvey, Whitney and Groves of the Boston Wharf Company, in the manner following:—

The filling is to be to grade thirteen with dredged material, and said material shall be dredged from the trenches to be made for the sea-wall herein before described; also, from Fort Point Channel and from the area shaded red, as described in section four of chapter three hundred and twenty-six of the Acts of the year eighteen hundred and sixty-eight, as may be directed by said Board of Harbor Commissioners, provided that filling may be taken from other portions of Boston Harbor, with the assent of the Harbor Commissioners and of the governor and council.

Fort Point Channel in front of the lands and flats above described and conveyed, as aforesaid, to said Harvey, Whitney and Groves by said Commonwealth, as well as in front of those pur-

chased of said Boston Wharf Company, shall be dredged by said company to such a depth of not less than twelve nor more than eighteen feet below low-water, and to such a width as said Board of Harbor Commissioners may direct in manner aforesaid.

The area shaded red mentioned in the foregoing section, shall be dredged by said company to such depth, and in such sections, as may be directed by the Harbor Commissioners, but is not to be dredged more than to twenty-three feet below mean low-water.

The filling shall be commenced at the Commissioners' line A, along the whole line between Fort Point Channel and lands of the Commonwealth, and the filling carried forward to the northerly sea wall, with such progress as to secure the completion of the filling of all the said territory as aforesaid, conveyed by the Commonwealth to said Harvey, Whitney and Groves, within three years from July first, A. D. eighteen hundred and sixty-nine, except as herein before provided, or the filling shall be made upon the eastern boundary of this territory, if the Harbor Commissioners, with the consent of the governor and council, shall so direct; and, at least, such an amount of filling shall be done upon the territory to be filled from and after August, eighteen hundred and sixty-nine, as, being averaged and applied to each month, will be equal to filling seventy thousand square feet of the surface of the territory to grade sixteen, per month; but the Harbor Commissioners, with the consent of the governor and council, may, for the term of one year from the date hereof, for good cause shown, waive this requirement to such an extent as they shall determine, provided, that the whole work of filling shall be completed within the time herein provided. The sections in progress of filling shall be wholly or partially enclosed by said sea-walls and by temporary bulkheads, to the satisfaction of the Board of Harbor Commissioners. The dredged material must be deposited to grade thirteen, and, so soon thereafter as is practicable, the territory thus filled must be raised to grade sixteen, by filling with clean gravel or other material, to the satisfaction of the Harbor Commissioners and the governor and council.

Said Harvey, Whitney and Groves may, adjacent to their said lands, construct, maintain and use for wharf purposes, a suitable platform, not to project over said Commissioners' line, and not to exceed fourteen feet in width outside of the top of the main sea-wall, and not to extend more than twenty-five feet from the base of the wall built upon piles on the easterly side of Fort Point Channel, but no part of the sea-wall built upon piles on the easterly side of Fort Point Channel shall be used for wharf purposes until a

platform shall have been erected on the outside of said wall in accordance with the annexed plan marked G.

Any and all plans for the drainage of the territory conveyed to said Harvey, Whitney and Groves, shall be submitted, before commencing the work, to said Harbor Commissioners, and shall be subject to their approval, and to the approval of the governor and council.

In testimony whereof, the said Harbor Commissioners, in behalf of said Commonwealth, have hereto set their hands and seals, and the said railroad company has hereto set its hand and seal by John S. Eldridge, its president, this twenty-first day of July, in the year of our Lord eighteen hundred and sixty-nine.

JOSIAH QUINCY. [SEAL.]

S. E. SEWALL. [SEAL.]

F. W. LINCOLN, JR. [SEAL.]

DARWIN E. WARE. [SEAL.]

BOSTON, HARTFORD & ERIE R. R. Co.,

By JOHN S. ELDRIDGE, *President*. [SEAL.]

Signed, sealed and delivered in the presence of

SAM. W. BATES.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK ss., July 26, A. D. 1869. Personally appeared the said Josiah Quincy, Samuel E. Sewall, F. W. Lincoln, Jr., and Darwin E. Ware, Harbor Commissioners, and acknowledged the foregoing instrument by them subscribed, to be the free act and deed of the Commonwealth of Massachusetts, and of themselves in behalf of said Commonwealth; and the said John S. Eldridge, and acknowledged the foregoing instrument to be the free act and deed of the said Boston, Hartford, and Erie Railroad Company. Before me,

SAM. W. BATES, *Justice of the Peace*.

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER, BOSTON, July 26, 1869.

Approved in Council,

OLIVER WARNER, *Secretary*.

MORTGAGE OF HARVEY AND OTHERS, TRUSTEES, TO
THE COMMONWEALTH OF MASSACHUSETTS.

Know all men by these presents, That whereas on the 20th day of November, A. D. 1868, in pursuance of an agreement made by and between the Boston Wharf Company, a corporation established under the laws of the Commonwealth of Massachusetts, and the Boston, Hartford and Erie Railroad Company, a corporation established under and by virtue of the laws of the States of Connecticut, Rhode Island, New York, and Massachusetts, said Boston Wharf Company, by deed dated on said 20th day of November, A. D. 1868, and to be recorded in Suffolk Registry of Deed, at the request and for the benefit of the Boston, Hartford and Erie Railroad Company, sold and conveyed to Peter Harvey, of Boston, in Suffolk County, James S. Whitney, of Brookline, in Norfolk County, and Henry B. Groves, of Salem, in Essex County, a certain tract of land and flats situate in that part of Boston called South Boston, in said Commonwealth, for the consideration of one million three hundred and fifty thousand dollars.

And whereas one hundred and fifty thousand dollars of said consideration is paid in a promissory note for that amount, executed by said railroad company, and payable to said Boston Wharf Company or order six years from said 20th day of November, A. D. 1868, with interest after three years at the rate of seven per cent. per annum, payable half yearly, and secured by a first mortgage executed by said Harvey, Whitney and Groves, to said Boston Wharf Company upon that part of the granted premises hereinafter described, which lies south of the Commissioners' line A of solid filling so called.

And whereas the remaining twelve hundred thousand dollars of the consideration aforesaid is received by the Boston Wharf Company in the bonds of said railroad company, payable to said Boston Wharf Company, or bearer, in twenty years from November 20, 1868, with interest at the rate of seven per cent. per annum, payable semi-annually, by interest coupons attached to said bonds, and said bonds are secured by a mortgage upon that part of the granted premises hereinafter described, which lies south of the line X Z, on the plan hereto annexed marked X, (subject, however, to the first mortgage above-mentioned to said Boston Wharf Company, of a portion of the same,) dated on said November 20, 1868, by said Harvey, Whitney and Groves, to Jacob W. Pierce, of Brookline,

in Norfolk County, Elisha Atkins, of Boston, in Suffolk County, and William Morton, of Newton, in Middlesex County, trustees for the benefit of the holders of the said bonds for twelve hundred thousand dollars purchase money as aforesaid.

And whereas the Commonwealth of Massachusetts by its Harbor Commissioners, by deed of even date herewith, and to be recorded in Suffolk Registry of Deeds, has conveyed to said Harvey, Whitney and Groves certain flats situated in said South Boston.

And whereas by an agreement concluded by and between the Commonwealth of Massachusetts by its Board of Harbor Commissioners, and the Boston, Hartford and Erie Railroad Company, of even date herewith, said Boston, Hartford and Erie Railroad Company has contracted and agreed to do, keep and perform, sundry matters and things in said agreement fully set forth, to which said agreement, to be recorded with this instrument, reference is hereby made for certainty in ascertaining the terms, conditions, and stipulations therein written and agreed upon by the parties thereto.

And whereas, under the provisions of an Act entitled, "An Act to aid the construction of the Boston, Hartford and Erie Railroad," passed in the year eighteen hundred and sixty-seven, and of an Act entitled "An Act in addition to an Act to aid the construction of the Boston, Hartford and Erie Railroad," passed in the year eighteen hundred and sixty-nine, said Boston, Hartford and Erie Railroad Company has received, and is to receive, sterling scrip or certificates of indebtedness, which scrip it is the duty of said railroad company to pay at maturity in gold, and the interest thereon in gold, as the same shall fall due, and accordingly the said Boston, Hartford and Erie Railroad Company has executed an agreement of date July 10, 1869, to the Commonwealth, as provided in statutes of 1869, chapter 450, section 3, to do the various things therein referred to and provided.

Now, therefore, this indenture witnesseth, that in consideration of the premises, and of one dollar, and other valuable considerations to them paid, the receipt of which is hereby acknowledged, the said Peter Harvey, James S. Whitney, and Henry B. Groves, and the Boston, Hartford and Erie Railroad Company, *cestui que trust* in the lands hereinafter described, do hereby grant, bargain, sell and convey unto the Commonwealth of Massachusetts, and to its assigns forever, a certain parcel of land and flats situated in that part of said Boston called South Boston, and bounded and described as follows, to wit:

Commencing at a point marked A on the plan marked X, hereto annexed, a duplicate of which is to be recorded herewith in the

Suffolk Registry of Deeds, thence running westerly to B, thence northerly through point C to point D, thence westerly to point E, thence northerly to point F, thence westerly to point G, thence northerly and easterly through points K, X and P to point Y, thence southerly through point Z to point L, thence easterly to point M, thence southerly through point H, to point A, and being all the premises conveyed to said Harvey, Whitney, and Groves by deed of said Commonwealth of even date herewith, and also all the premises conveyed to said Harvey, Whitney and Groves by deed of said Boston Wharf Company by said deed dated November 20, 1868, except a small portion of the part released to said Commonwealth by deed of even date herewith, to be recorded in the Suffolk County Registry of Deeds.

To have and to hold the afore-granted premises with all the rights, easements, privileges and appurtenances to the same belonging, or in any way appertaining, to said Commonwealth of Massachusetts and its assigns, to its and their own use and behoof forever.

And we, the said Harvey, Whitney and Groves, for ourselves, and our heirs, executors and administrators, do covenant with said Commonwealth of Massachusetts and its assigns that the above-granted premises, are free from all incumbrance made by us except as herein before stated, and that we will, and our heirs, executors, and administrators, shall warrant and defend the same to the said Commonwealth of Massachusetts and its assigns against the lawful claims and demands of all persons claiming, or to claim by, through, or under us, excepting only those claiming or to claim under and by virtue of the mortgages heretofore referred to.

Provided, however, that if the said Boston, Hartford and Erie Railroad Company shall well and truly keep and perform each and every duty and obligation it is by the terms of said contract with said Commonwealth of Massachusetts, of date of July 21, 1869, bound and obliged to keep and perform, and further—

Provided, that if said Boston, Hartford and Erie Railroad Company shall pay, or cause to be paid its note of even date herewith, payable in twenty years after date, with interest after three years from date, to the treasurer of the Commonwealth of Massachusetts or order, for the sum of five hundred and forty-five thousand five hundred and five dollars, when the same shall fall due, with the interest thereon, payable semi-annually at the rate of six per cent. per annum, and also pay in cash on demand at the rate of fifty cents per square foot for any excess which the land conveyed to said Harvey, Whitney and Groves may be found on measurement to

contain, over and above the estimated amount of one million ninety-one thousand and ten feet, with said interest after three years from the date hereof, and further—

Provided, that if said Boston, Hartford and Erie Railroad Company shall well and truly pay, or cause to be paid in gold, all the scrip it has received, or may receive, from the Commonwealth of Massachusetts, under the provisions of the Act passed in the year eighteen hundred and sixty-seven, entitled “An Act to aid the construction of the Boston, Hartford and Erie Railroad,” and under the provisions of statutes of 1869, chapter 450, and the interest on said scrip in gold as the same shall fall due, and shall also do, keep and perform, all the other matters and things which it is bound to do, keep and perform by the terms of the agreement provided for by statutes of 1869, chapter 450, above referred to, and save said Commonwealth harmless from all costs, damage and expense, on account of the issue of said scrip, then this deed shall be absolutely void to all intents and purposes.

And *provided, also*, that if default shall be made in the payment of said note, or of the interest accruing thereon, or of any part thereof, or in the fulfilment of any of the conditions of this mortgage, or any of the agreements of the said Boston, Hartford and Erie Railroad Company herein before set forth or referred to, and if any such default shall continue for six months after notice of such default shall have been given in writing to said Harvey, Whitney and Groves by the governor of the Commonwealth, then, and in either of said events, it shall be lawful for the said Commonwealth or its assigns, to sell and dispose of the granted premises, with all the improvements that may be thereon, at public auction, such sale to be upon or near the premises hereby granted, without further notice or demand except giving notice of the time and place of sale by advertising twice in each of three successive weeks in three daily newspapers printed in the city of Boston aforesaid: and the said Commonwealth or its assigns in their own names, or as the attorneys of the said Harvey, Whitney and Groves, and of the said Boston, Hartford and Erie Railroad Company, for that purpose by these presents duly authorized and empowered, may convey the same absolutely and in fee simple to the purchaser or purchasers accordingly; and out of the proceeds and money arising from such sale may retain all sums then secured by this deed, whether then, or thereafter payable, together with interest and all costs and expenses, and shall pay the surplus, if any, to the said Harvey, Whitney and Groves, or their personal representatives or assigns, or to the court ordering or confirming such sale; and such sale shall for-

ever bar the said Harvey, Whitney and Groves, and the said Boston, Hartford and Erie Railroad Company, and each and all of them, and all persons or corporations claiming under and through them or either of them, from all right and interest in the premises, or any part thereof, at law or in equity.

And it is further agreed by the said parties hereto that the said Commonwealth or its assigns may purchase at the said sale, and that no other purchasers shall be answerable for the application of the purchase money.

And it is further agreed by all parties hereto without prejudice to the power of sale herein before provided for, and in addition thereto, that in case of any such default, at the election of the said Commonwealth or its assigns, an entry may be made by them and possession may be taken of the mortgaged estate and property, for foreclosure of this mortgage, which being continued for three years from and after, shall forever at law and in equity be a perpetual bar to the legal and equitable title and interest of the said mortgagors, and of the said railroad company, and of all persons claiming or to claim by, through or under them or either of them, in the mortgaged premises or any part thereof.

Provided, however, that until default in the payment of the said sum or interest or of some part thereof or other default as herein provided, the said Commonwealth shall have no right to enter and take possession of the granted premises.

In witness whereof, said Peter Harvey, James S. Whitney, and Henry B. Groves have hereunto set their names and affixed their seals; and said Boston Hartford and Erie Railroad Company has caused its corporate name to be subscribed, and its corporate seal to be affixed by its president, John S. Eldridge, this twenty-first day of July, A. D. eighteen hundred and sixty-nine.

PETER HARVEY. [SEAL.]

JAMES S. WHITNEY. [SEAL.]

HENRY B. GROVES. [SEAL.]

BOSTON, HARTFORD & ERIE R. R. Co.,

By JOHN S. ELDRIDGE, *President*. [SEAL.]

Signed, sealed, and delivered in presence of

SAM. W. BATES,

J. C. WATSON.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK, SS. BOSTON, July 26, 1869. Then personally appeared James S. Whitney, and Henry B. Groves, signers and sealers of the above

instrument, and acknowledged the same to be their several free act and deed before me, and also John S. Eldridge, who acknowledged that he executed said instrument as the free act and deed of the Boston, Hartford and Erie Railroad Company as its president, before me.

SAM. W. BATES, *Justice of the Peace.*

At a meeting of the directors of the Boston Hartford and Erie Railroad Company duly called and held at Boston, on the 12th day of June, A. D. 1869, it was unanimously—

Voted, That our president, with the advice and consent of the executive committee, is hereby authorized and empowered to purchase of the Commonwealth of Massachusetts any of its lands and flats in Boston Harbor upon such terms and conditions as to price, payment, and filling and building a sea-wall around any portion of the same as may be agreed ; and the president may execute and deliver in the name of this company any note, bond, contract, deed or mortgage of, or concerning the purchased estates, to secure the performance of any of the above-named obligations as principal, or as *cestuy que trust*, in case of conveyance of such premises to trustees. And said lands and flats, if purchased, may be conveyed by said Commonwealth to any trustees said executive committee may agree upon for the benefit of said company ; and said trustees may make and execute any mortgage thereof said committee may direct, to secure any contract or obligation said president may agree upon or give under the provisions of this or any former vote of this board, or the executive committee ; and said president or said trustees, or both, may include in such conveyance, any lands or flats purchased of the Boston Wharf Company.

Our trustees, Peter Harvey, James S. Whitney and Henry B. Groves, trustees of lands purchased by us of the Boston Wharf Company, are instructed and empowered to release and quitclaim to the Commonwealth of Massachusetts, so much of the lands and flats purchased of said Boston Wharf Company by this company, as the executive committee may direct, and by such instrument as said committee may approve ; and our president shall in the name and behalf of this company, join in said release as *cestuy que trust* in said lands and flats.

I certify further that at the date of the passage of the above vote, and ever since, John S. Eldridge, Mark Healey, and Henry N. Farwell were and are the executive committee of the directors of the

Boston, Hartford and Erie Railroad Company. Dated July 21, 1869.

A true exemplification of record.

Attest:

THOMAS E. GRAY, *Secretary, pro tem.*

STATE OF MASSACHUSETTS.

BOSTON, JULY 21, 1869.

We, John S. Eldridge, Mark Healey, and Henry N. Farwell, executive committee of the directors of the Boston, Hartford and Erie Railroad Company, hereby approve of and consent to the making, execution, and delivery of the following described instruments which will be found recorded in Suffolk Records of Deeds, to which records reference is hereby made.

1st. A release deed of the Commonwealth of Massachusetts by its Harbor Commissioners to Peter Harvey, James S. Whitney, and Henry B. Groves, trustees, and a release deed of said Harvey, Whitney and Groves to said Commonwealth, of date of July 21, 1869.

2d. A deed by said Commonwealth by said Harbor Commissioners to said Harvey, Whitney and Groves, of date of July 21, 1869.

3d. Contract of agreement of the Commonwealth by said Harbor Commissioners, with the Boston, Hartford and Erie Railroad Company of date July 21, 1869.

4th. Mortgage deed of said Harvey, Whitney and Groves to said Commonwealth of date of July 21, 1869.

5th. Declaration of trust of said Harvey, Whitney and Groves, and said Boston, Hartford and Erie Railroad Company, of date of July 21, 1869.

JOHN S. ELDRIDGE,
MARK HEALEY,
HENRY N. FARWELL,
Executive Committee.

DECLARATION OF TRUST BY HARVEY AND OTHERS
TO THE BOSTON, HARTFORD AND ERIE RAIL-
ROAD COMPANY.

Indenture of two parts made this twenty-first day of July, A. D. 1869, by and between Peter Harvey, of Boston, James S. Whitney, of Brookline, and Henry B. Groves, of Salem, and all of Massachusetts, of the first part, and the Boston, Hartford and Erie Railroad Company, a corporation duly established under and by virtue of the laws of the States of Connecticut, Massachusetts, Rhode Island and New York, of the second part, witnesseth :

Whereas, by a proper deed made and executed on the 20th day of November, A. D. 1868, and to be recorded in Suffolk Records of Deeds in Suffolk County, the Boston Wharf Company, a corporation duly established under the laws of the State of Massachusetts, sold, assigned and conveyed to said Harvey, Whitney and Groves, as joint tenants, certain lands and flats in South Boston, to which deed reference is made for all matters and things therein contained ; and whereas, by deed of said last date, said Harvey, Whitney and Groves did sell, assign and convey a portion of said lands and flats in two separate parcels by two separate deeds of conveyance, one to said Boston Wharf Company, and one to Jacob W. Pierce, Elisha Atkins and William Morton, trustees for the benefit of said Boston Wharf Company, at the request of said Boston, Hartford and Erie Railroad Company, to secure a certain note of said company for one hundred and fifty thousand dollars, and certain bonds, amounting in the principal sum to twelve hundred thousand dollars, as will appear by said deed and certain contracts between said trustees and the parties hereto, all of like date and all of which will be found of record in Suffolk Records of Deeds :

And whereas, by deed of date of July 21st, A. D. 1869, said parties of the first part have released, by a proper quitclaim deed, all their interest in a portion of the lands and flats conveyed to them by the Boston Wharf Company, as above recited, to the Commonwealth of Massachusetts ; and in and by the same instrument said Commonwealth of Massachusetts has released to said party of the first part all its right, title and interest in and to the remaining part of said lands and flats by said Boston Wharf Company conveyed to said party of the first part. And whereas, by deed of date of July 21st, A. D. 1869, said Commonwealth of Massachusetts, acting by its Harbor Commissioners, conveyed to said

party of the first part certain lands and flats in such conveyance particularly described; and whereas, said party of the first part has, by deed of even date with said last above deed, conveyed all the lands and flats so to them conveyed by said Commonwealth by its Harbor Commissioners, and also all the lands and flats conveyed to said party of the first part by said Boston Wharf Company, except that part heretofore conveyed to the Commonwealth of Massachusetts by quitclaim deed, all of which conveyances and contracts heretofore referred to will be found recorded in the Suffolk Records of Deeds in Suffolk County, to all which reference is hereby made for certainty in ascertaining the matters and things therein contained, all of which conveyances and contracts have been made at the request and for the benefit of the Boston, Hartford and Erie Railroad Company.

Now, therefore, know all men by these presents, That the parties hereto do acknowledge, testify and declare as follows, to wit:

First. Said Peter Harvey, James S. Whitney and Henry B. Groves acknowledge, testify and declare that the lands and flats so conveyed to them by the Boston Wharf Company, and the lands and flats so conveyed to them by the Commonwealth of Massachusetts, acting by its Harbor Commissioners, are the proper purchase of said Boston, Hartford and Erie Railroad Company, and that the title thereto is held by them as joint tenants in trust, and for the use and benefit of said railroad company, its successors and assigns.

Second. Said Harvey, Whitney and Groves further acknowledge, testify and declare that they severally will, and that their several legal representatives shall, on the request of said Boston, Hartford and Erie Railroad Company, made by its directors, and at its charges, make any and all conveyances requested, of any portion or all of said lands and flats, to said railroad company, or any person or persons or corporations as may be designated, conveying thereby all the right, title and interest said Harvey, Whitney and Groves have in and by said conveyances from said Boston Wharf Company and said Commonwealth of Massachusetts, and subject to the above-named conveyances to secure the payment of the note of said railroad company to said Boston Wharf Company, and the bonds for twelve hundred thousand dollars delivered said Boston Wharf Company by said railroad company, and the contracts and agreements of said railroad company to and with said Commonwealth of Massachusetts, all to be found in the above-named instruments on record in Suffolk Records of Deeds, and referred to as aforesaid. Said party of the first part further agrees to make any

disposition of their interest in said above-described lands and flats that they may lawfully do on request of said Boston, Hartford and Erie Railroad Company.

Third. The Boston, Hartford and Erie Railroad Company doth acknowledge, testify and declare that said lands and flats so conveyed by said Boston Wharf Company, and by said Commonwealth of Massachusetts, as aforesaid, to said Peter Harvey, James S. Whitney and Henry B. Groves, are its proper estate, and that such portion thereof as is now held by said Harvey, Whitney and Groves, is held by them as its trustees, and that it is its duty to pay, and that it will pay, the expenses attending and proper compensation for the execution of such trust, as well as all notes, bonds and interest on the same secured by the above-described deeds, as well as fulfil all the obligations and conditions found in the contract and agreements of said railroad company with the Commonwealth of Massachusetts secured by such conveyances as aforesaid set forth, to which instruments reference is hereby had for ascertaining with certainty the contents of the same.

In witness whereof, said Peter Harvey, James S. Whitney and Henry B. Groves, and the said Boston, Hartford and Erie Railroad Company, by its president, John S. Eldridge, have hereunto set their names and affixed their seals this 21st day of July, A. D. 1869.

PETER HARVEY.

[SEAL.]

JAMES S. WHITNEY.

[SEAL.]

HENRY B. GROVES.

[SEAL.]

BOSTON, HARTFORD & ERIE R. R. Co.,

By JOHN S. ELDRIDGE, *President*.

[SEAL.]

Signed, sealed and delivered in presence of

SAM. W. BATES.

STATE OF MASSACHUSETTS.

SUFFOLK COUNTY, ss. July 24, A. D. 1869. Then personally appeared Peter Harvey, James S. Whitney and Henry B. Groves, and acknowledged the above instrument to be their several free act and deed; and also the said John S. Eldridge, who acknowledged that he executed said instrument as the free act and deed of said Boston, Hartford and Erie Railroad Company. Before me,

SAM. W. BATES, *Justice of the Peace*.

AGREEMENT OF PIERCE AND OTHERS, TRUSTEES,
WITH THE COMMONWEALTH OF MASSACHUSETTS.

Whereas, by a deed of mortgage made by Peter Harvey, of Boston, in the county of Suffolk, James S. Whitney, of Brookline, in the county of Norfolk, and Henry B. Groves, of Salem, in the county of Essex, all in the Commonwealth of Massachusetts, to the Boston Wharf Company, to secure the payment of the note of the Boston, Hartford and Erie Railroad Company to said Boston Wharf Company for one hundred and fifty thousand dollars, dated November 20, 1868, and to be recorded in Suffolk Registry of Deeds, it is provided that in case of default, the said Boston Wharf Company may sell and dispose of the mortgaged premises at public auction "without further notice or demand except giving notice of the time and place of sale by advertising twice in each of three successive weeks in three daily newspapers printed in the city of Boston, aforesaid."

And whereas, by a deed of mortgage made by the said Harvey, Whitney and Groves to Jacob W. Pierce, of Brookline, in the county of Norfolk, Elisha Atkins, of Boston, in the county of Suffolk, and William Morton, of Newton, in the county of Middlesex, all of the Commonwealth of Massachusetts, to secure the payment of twelve hundred thousand dollars of the bonds of the Boston, Hartford and Erie Railroad Company, and dated November 20, 1868, and to be recorded in Suffolk Registry of Deeds, it is provided that in case of default, the said Pierce, Atkins and Morton may sell and dispose of the mortgaged premises at public auction "without further notice or demand except giving notice of the time and place of sale by advertising twice in each of three successive weeks in three daily newspapers printed in the city of Boston aforesaid."

And whereas, the said Boston Wharf Company are the present holders of all the said twelve hundred thousand dollars of bonds,—

And whereas, the said Harvey, Whitney and Groves have made a mortgage deed of all of said premises, together with certain other premises, to the Commonwealth of Massachusetts, which deed is dated July 21, 1869, and is to be recorded in Suffolk Registry of Deeds.

Now, therefore, in consideration of one dollar and other valuable considerations paid to said Boston Wharf Company, and to the said Pierce, Atkins and Morton, trustees as aforesaid, the receipt of which is hereby acknowledged, the said Boston Wharf Company

and the said Pierce, Atkins and Morton, as such trustees for themselves, their successors, heirs, and assigns, severally in respect of the mortgages held by said company and by said trustees respectively, but not jointly, or the one for the other, promise and agree to and with the said Commonwealth, that they severally will not sell or dispose of said mortgaged premises, or any part thereof, under said provisions of their respective mortgage deeds, without first giving notice in writing to the governor of said Commonwealth of the time appointed for said sale, which said notice to the governor shall be given at least nine months prior to the time appointed for said sale.

In testimony whereof, the said Pierce, Atkins and Morton, have hereunto set their hands and seals, and the said Boston Wharf Company has hereunto set its hand and seal by Jacob Sleeper, its president, thereto duly authorized this twenty-first day of July, in the year of our Lord eighteen hundred and sixty-nine.

BOSTON WHARF COMPANY,

By JACOB SLEEPER, *President*. [SEAL.]

JACOB W. PIERCE. [SEAL.]

ELISHA ATKINS. [SEAL.]

WM. MORTON. [SEAL.]

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK, SS. BOSTON, July 24, 1869. Then personally appeared the above-named Jacob Sleeper, president of the Boston Wharf Company, and acknowledged the foregoing instrument by him subscribed, to be the free act and deed of the said Boston Wharf Company. Before me,

A. C. WASHBURN, *Justice of Peace*.

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER, BOSTON, July 26, 1869.

Approved in Council,

OLIVER WARNER, *Secretary*.

AGREEMENT OF THE BOSTON, HARTFORD AND ERIE
RAILROAD COMPANY AND TRUSTEES WITH THE
BOSTON WHARF COMPANY.

An indenture of two parts made this twenty-first day of July, A. D. 1869, by and between the Boston, Hartford and Erie Railroad Company, a corporation duly established by law, and Peter Harvey, James S. Whitney, and Henry B. Groves, as they are trustees for said railroad company, party of the first part, and the Boston Wharf Company, a corporation established by law, and Jacob W. Pierce, Elisha Atkins and William Morton, trustees for the said wharf company, and for the holders of certain bonds issued by said railroad company, party of the second part, Witnesseth : that in consideration that at the request of the said party of the first part the said party of the second part have executed and delivered at the said time with the said party of the first part an indenture or release to the Commonwealth of Massachusetts, of certain parts of the flats mortgaged to said Pierce, Atkins and Morton as trustees as afore-stated, by said Harvey, Whitney and Groves, the said party of the first part, do for themselves and their successors, representatives and assigns covenant, and agree to and with the said party of the second part, and their successors, representatives and assigns, that in case the said Boston Wharf Company, or the said Pierce, Atkins and Morton as such trustees, or their successors, or assigns, or either of them shall come lawfully into possession of the territory or any part of the territory released by the Board of Harbor Commissioners on behalf of the Commonwealth of Massachusetts, in and by the afore-mentioned indenture, by reason of any breach of the conditions of the mortgages made by said Harvey, Whitney and Groves to the said Boston Wharf Company, and to said Pierce, Atkins and Morton, trustees as aforesaid, or either of them, the said Boston Wharf Company, and the said Pierce, Atkins and Morton, trustees as aforesaid, or either of them, their successors, heirs and assigns, may enclose and fill the said territory, or any part thereof, in the manner and to the extent provided in the Indenture herein before referred to ; and the cost of such filling and enclosure shall be allowed and paid to the party making it as a legal charge and expenditure under the said mortgages and as part of the mortgage debt in case the premises shall be redeemed by the mortgagors, or their representatives or any party claiming

or to claim by or through the said railroad company, and the said Harvey, Whitney and Groves or either of them.

In witness whereof the said Boston, Hartford and Erie Railroad Company hath hereto set its seal and caused these presents to be subscribed by its president thereto duly authorized, and the said Harvey, Whitney and Groves have hereto set their hands and seals, the day and year first above written.

JAMES S. WHITNEY.

[SEAL.]

HENRY B. GROVES.

[SEAL.]

PETER HARVEY.

[SEAL.]

BOSTON, HARTFORD & ERIE R. R. Co.,

BY JOHN S. ELDRIDGE, *President*.

[SEAL.]

In presence of

H. S. BARRY.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK, SS. BOSTON, July 24th, A. D. 1869. Then personally appeared John S. Eldridge and acknowledged the foregoing deed by him subscribed to be the free act and deed of the Boston, Hartford and Erie Railroad Company. Before me.

H. S. BARRY, *Justice of the Peace*.

AGREEMENT OF THE BOSTON, HARTFORD AND ERIE
RAILROAD COMPANY WITH THE COMMONWEALTH
OF MASSACHUSETTS.

Know all men by these presents, That whereas in and by an Act of the General Court of the Commonwealth of Massachusetts, approved on the twenty-second day of June, A. D. eighteen hundred and sixty-nine, entitled "An Act in addition to an Act to aid the Construction of the Boston, Hartford and Erie Railroad," it is enacted as follows, namely:—

AN ACT in addition to an Act to aid the Construction of the Boston, Hartford and Erie Railroad.

Be it enacted, &c., as follows:

SECT. 1. For the purpose of aiding the Boston, Hartford and Erie Railroad Company in the construction of its railroad from the city of Boston to Fishkill in the state of New York, for the equipment of the same, for filling its flats in Boston, and in building a sea-wall around them, and in construction thereon of buildings for station and railroad accommodation, the treasurer of the Commonwealth is hereby authorized and instructed to issue scrip or certificates of indebtedness, in the name and behalf of the Commonwealth, and in the manner herein designated, to such an amount as with the amount heretofore authorized to be issued in aid of said company, shall make the sum of five millions of dollars, which shall be expressed in the currency of Great Britain at the rate of four and eighty-four one-hundredths dollars to the pound sterling, and payable to the bearer thereof in London, and bearing interest of five per cent. per annum payable semi-annually in London on the first days of January and July; which said scrip or certificates shall be redeemable in London on the first day of January, in the year nineteen hundred, and shall bear date on the first day of January or July, which shall next precede the issue of the same. All said scrip shall be countersigned by the governor of the Commonwealth for the time being, and be deemed a pledge of the faith and credit of the Commonwealth for the redemption thereof. The principal and interest on the scrip hereby authorized shall be expressed in the currency of Great Britain, and in paying the same the cost of exchange shall be paid by the Boston, Hartford and Erie Railroad Company in gold coin or its equivalent, at the option of the treasurer of the Commonwealth, and at least one million dollars of

said loan shall be expended in the construction of said sea-wall and the filling said flats.

SECT. 2. The governor and council shall from time to time ascertain themselves, or by proper agents to be by them appointed whether all contracts now or hereafter to be made with the Commonwealth in relation to the said flats for expenditures to be made in improving the same and in the construction of its road and all conditions required to entitle it to receive scrip have been complied with by said railroad company; and whenever the governor and council shall find that said railroad company shall have, since May first of the present year, complied with such conditions and agreements, and properly expended at least one hundred thousand dollars in construction of its railroad between Boston and Fishkill aforesaid, or in the purchase of new equipment to be used on said line of road, or in filling flats now owned by said railroad company, or which it may hereafter purchase of the Commonwealth on the northerly shore of South Boston, and in building a sea-wall around or along the same, as now is, or may be, provided in any contract between said railroad company and the Commonwealth, or in construction of buildings thereon for railroad uses, then said governor and council shall cause certificate thereof to be made to the treasurer of the Commonwealth, and scrip to the amount expended shall be delivered under the terms and provisions of this act to said railroad company, (reckoning a pound sterling to represent four dollars and eighty-four cents,) and for every additional sum of one hundred thousand dollars expended by said railroad company, in the manner and for the purposes aforesaid, scrip to the amount expended shall be delivered, in the manner and upon the terms aforesaid, to said railroad company, until the whole amount authorized shall have been issued and delivered. And no further issue or delivery of scrip shall be made to said company on account of any expenditure prior to May first of the present year. Any expenses incurred by the Commonwealth, or by the governor and council or any committees or agents of the same in relation to the loan hereby or heretofore authorized, shall be paid by said railroad company, together with a proper sum in compensation for any services of such agents, to be determined by the governor and council.

SECT. 3. No scrip shall be delivered to the treasurer of said railroad company under the provisions of this act until an agreement shall have been executed by said company to the Commonwealth, in a form approved by the attorney-general of the Commonwealth, and delivered to the treasurer of the Commonwealth, and conditioned that said railroad company shall comply with the pro-

visions of this act, and shall indemnify and save harmless the Commonwealth from all expenses incurred, or loss or damage on account of said scrip, and that said railroad company shall and will well and truly pay the principal sum of said scrip in gold coin when the same shall become due and payable, and interest thereon in gold coin as the same shall fall due, together with the cost of exchange on both principal and interest as heretofore provided, and shall have executed to the Commonwealth a mortgage satisfactory to the governor and council, of the flats purchased, or which may hereafter be purchased, of the Commonwealth, and of the lands and flats purchased of the Boston Wharf Company, in security for said purchase or purchases of the Commonwealth and for the loan hereby authorized, and for any other liability said railroad company may incur to said Commonwealth in and by any contract made or hereafter to be made, and shall deliver to the treasurer of the Commonwealth, before said railroad company shall receive the scrip as aforesaid, as security for the performance of the conditions of said agreement, one thousand dollars in the bonds secured by the mortgage to Robert H. Berdell and others, trustees, to and for every one thousand dollars to be received by said treasurer of the Boston, Hartford and Erie Railroad Company in scrip as herein provided.

SECT. 4. There shall be reserved and set apart by said railroad company from each one hundred thousand dollars of the amount received from the sale of scrip issued to said railroad company from the Commonwealth, such a sum as the governor and council shall direct, which shall within thirty days from and after said scrip is delivered, be paid to the commissioners of the sinking fund established by the act to which this is in addition, to be held and invested agreeably to the provisions establishing said fund, and the sum so reserved shall not be a less amount than shall with the accumulations produce at the maturity of such scrip an amount equal to the scrip so issued.

SECT. 5. The governor and council shall themselves, or by their committees or agents appointed for that purpose, at all times, until the payment of the scrip issued under this act, and of the act to which this is in addition, have free access to all the books and accounts of said railroad company for the purpose of examination.

SECT. 6. Section four of chapter two hundred and eighty-four of the acts of the year eighteen hundred and sixty-seven, and also so much of said chapter as relates to the appointment of commissioners, and the duties to be performed by them, and the conditions

the issue of scrip, so far as relates to the further issue thereof, is hereby repealed,

SECT. 7. There shall be two directors of said Boston, Hartford and Erie Railroad Company on the part of the Commonwealth, with all the rights and powers of stock directors. They shall be appointed by the governor and council, and upon the passage of this act one shall be appointed to serve for one year and one to serve for two years, and each year thereafter one shall be appointed to serve for two years.

SECT. 8. And the said Boston, Hartford and Erie Railroad Company shall grant, at *pro rata* rates, to all parties applying therefor, the privilege to run over its road, and over all other roads under the control of the said company, for the purpose of carrying on the express business between all the towns upon the line of said road or roads.

SECT. 9. This act shall take effect upon its passage. [*Approved June, 22, 1869.*]

Now, therefore, the said Boston, Hartford and Erie Railroad Company, in consideration of the passage of said act, and having made application for an issue of scrip under the same, do hereby agree to comply with all the provisions of said act, and to indemnify and save harmless and protect the said Commonwealth from all expenses now or hereafter incurred on account of any and all scrip which may be issued under said act, and from all loss or damage on account of said scrip, and well and truly to pay the principal sum of said scrip in gold coin, when the same shall become due and payable, and interest thereon in gold coin as the same shall fall due, together with the cost of exchange on both principal and interest as provided in said act, and to deliver to the treasurer of the Commonwealth before said railroad company shall receive said scrip, as security for the performance of the conditions of this agreement, one hundred thousand dollars in the bonds secured by the mortgage to Robert H. Berdell, and others, trustees referred to in said act, to and for every one hundred thousand dollars to be received by the treasurer of said Boston, Hartford, and Erie Railroad Company in scrip of the Commonwealth as provided by said act.

In witness whereof the said Boston, Hartford and Erie Railroad Company has caused its seal to be hereunto affixed, and these presents to be signed in its behalf by John S. Eldridge, its president, this tenth day of July, in the year of our Lord eighteen hundred and sixty-nine.

BOSTON, HARTFORD & ERIE R. R. Co.,
By JOHN S. ELDRIDGE, *President*. [SEAL.]

Executed and delivered in presence of
THOMAS E. GRAVES.

NOTICE.

A meeting of the stockholders in the Boston, Hartford and Erie Railroad Company will be held at the office of the company, No. 12 Pemberton Square, Boston, in Massachusetts, on Tuesday, the 6th day of July, A.D., 1869, at 12 o'clock noon, to see,—

1st. If said company will accept an Act of the Commonwealth of Massachusetts, approved June 22, 1869, entitled "An Act in addition to an Act to aid the construction of the Boston, Hartford and Erie Railroad," and to pass any votes necessary and proper to obtain the benefits of the provisions of said act.

2d. To see if said company will vote to amend and change its by-laws, and if so amended to do all things such amendment may authorize.

JUNE 28, 1869.

H. N. OTIS, *Secretary*.

Pursuant to the above notice which I certify was published as the by-laws of said company require, met at the time and place appointed: Hon. J. S. Eldridge, president, in the chair.

The secretary being absent, Thomas E. Graves was lawfully chosen secretary or clerk, *pro tem.* and sworn to the duties as follows:—

STATE OF MASSACHUSETTS.

BOSTON, ss., July 6, 1869. Then personally appeared Thomas E. Graves and was duly sworn as clerk, *pro tem.* of the Boston, Hartford and Erie Railroad Company. Before me,

H. S. BARRY, *Justice of the Peace*.

Then voted unanimously,—

1st. That this corporation does hereby accept the provisions of an Act of the Commonwealth of Massachusetts, approved June 22, 1869, entitled "An Act in addition to an Act to aid the construction of the Boston, Hartford and Erie Railroad."

2d. *Voted.* That the president of the corporation, John S. Eldridge, be and he is hereby authorized and empowered in the name and on behalf of the corporation to execute and deliver the contracts or agreements, and all other instruments required by the above-named Act passed by the legislature of Massachusetts, to be executed by the corporation, or which may by him be deemed necessary in order to enable this company to receive the full benefits of the provisions of said Act.

A true record.

Attest:

THOMAS E. GRAVES, *Clerk, pro tem.*

Boston, July 12, 1869. I certify that the foregoing is a correct copy from the records of the Boston, Hartford and Erie Railroad Company.

Attest:

THOMAS E. GRAVES, *Clerk, pro tem.*

Examined and approved.

CHARLES ALLEN, *Attorney-General.*

COMMONWEALTH OF MASSACHUSETTS.

COUNCIL CHAMBER, BOSTON, July 26, 1869.

Approved in Council.

OLIVER WARNER, *Secretary.*

AGREEMENT BETWEEN THE COMMONWEALTH OF
MASSACHUSETTS AND THE BOSTON AND ALBANY
RAILROAD COMPANY.

Whereas, under an Act entitled “An Act authorizing the extension of the Boston and Albany Railroad to deep water at South Boston, and for other purposes,” being chapter 461 of the Acts of the year 1869, the Boston and Albany Railroad Company desire to purchase a parcel of flats in South Boston, of the Commonwealth of Massachusetts :

Now, therefore, the following Articles of Agreement made this eighth day of December, A. D. eighteen hundred and sixty-nine, by and between the Commonwealth of Massachusetts, party of the first part, acting by its Board of Harbor Commissioners, and the Boston and Albany Railroad Company, a corporation organized under the laws of said Commonwealth, party of the second part,
Witness :

That in consideration of the covenants and agreements hereinafter made by the said party of the second part, the party of the first part hereby covenants and agrees with the said party of the second part, that it will in six years from the first day of October, A. D. 1869, convey to said party of the second part by a good and sufficient warranty deed, a certain parcel of flats situated in that part of Boston known as South Boston, and being a portion of the flats known as the South Boston Flats, bounded and described as follows : Beginning at the north-westerly corner of the same on the exterior line, as shown on the plan annexed to the second annual report of the Board of Harbor Commissioners, and defined in said report, which point is also the north-easterly corner of the parcel of flats conveyed by the said Commonwealth to Peter Harvey, James S. Whitney and Henry B. Groves, trustees for the Boston, Hartford and Erie Railroad Company, by deed dated July 21, A. D. 1869, and recorded with Suffolk County Deeds in Lib. 970, Fol. 15, and is marked Y, on the plan hereto annexed marked A, and running south-westerly along the easterly line of land of said Harvey, Whitney and Groves, trustees as aforesaid, to a point on said plan marked L, in the Commissioners’ line A, established by chapter 385 of the Acts of the year 1853, distant ten hundred and ninety-three feet easterly from the Commissioners’ line on the east-

erly side of Fort Point Channel, established by chapter 35 of the Acts of the year 1840; thence running easterly along said Commissioners' line A, one hundred and fifty-six and a half feet to the point on said plan marked M; thence running south-westerly along the land of said Harvey, Whitney and Groves, trustees, parallel to said Commissioners' line on the easterly side of said Fort Point Channel six hundred and eighty-five feet to a point marked N, on the plan hereto annexed, marked A; thence running south-easterly at right angles to the last described line seven hundred and fourteen feet to a point marked O, on said plan A; thence running north-easterly to a point marked S, on said plan A, in said exterior line, as shown on the plan annexed to the second annual report of the Harbor Commissioners, eight hundred and seventy-eight feet easterly from the point of beginning; thence westerly eight hundred and seventy-eight feet to the point of beginning: *provided, however*, that said party of the first part shall not be bound to make such conveyance until said parcel of flats shall have been occupied and improved by the filling of the same, and the construction on the same of walls and bulkheads and otherwise as hereinafter covenanted and agreed by said party of the second part.

Said covenant and agreement are, and said conveyance when made shall be upon the following reservations and restrictions:—

First. Said Commonwealth reserves in said territory the right by its Harbor Commissioners, subject to the approval of the governor and council, to locate upon, over and across the said territory Northern Avenue, seventy-five feet in width, and Eastern Avenue, sixty-six feet in width, and to locate an extension or continuation of B Street as far as to its intersection with said Northern Avenue, substantially as said avenues and street are shown on said plan marked A, and to appropriate and devote the territory embraced within the limits of said avenues and street when so located, to all the uses and purposes of public streets and highways without compensation to said party of the second part or their successors for the territory appropriated or the filling of the same.

Second. Any and all plans for the drainage of said parcel of flats when filled shall be submitted, before commencing the work for such drainage, to the Board of Harbor Commissioners, and shall be subject to their approval and the approval of the governor and council.

And said party of the second part in consideration of the covenants and agreements of said party of the first part, hereby covenants and agrees with said party of the first part, that it will pay

to said party of the first part or its assigns, in three years from the first day of October, A. D. 1869, four hundred and thirty-five thousand six hundred dollars, (\$435,600,) either in cash or the bonds of said party of the second part, payable in twenty years from the first day of October, A. D. 1872, with interest thereon at the rate of six per centum per annum, payable semi-annually.

And said party of the second part for the consideration aforesaid, further covenants and agrees with said party of the first part, that it will build within six years from said first day of October, A.D. 1869, unless, for good cause shown, the Harbor Commissioners, with the consent of the governor and council, shall extend said time, a sea-wall, commencing at a point in the north-westerly boundary line of said parcel of flats herein before bounded and described, distant southerly one foot from the said exterior line, as the same is laid down on the plan annexed to the second annual report of the Board of Harbor Commissioners, and extending southeasterly parallel to said exterior line to the easterly boundary line of said parcel of flats, and unite said wall with the sea-wall built on a line one foot within said exterior line, and on the said adjoining westerly parcel of flats conveyed by the Commonwealth to said Harvey, Whitney and Groves, trustees, so that both walls shall form a continuous and uniform structure. The said sea-wall shall be built by said party of the second part on said line parallel to said exterior line, and one foot within the same, as shown by the red line on the said plan hereto annexed marked A, and in such location as shall be marked out by the engineer of the Board of Harbor Commissioners previously to the commencement of the work of building the same by the party of the second part, and said party of the second part shall preserve the location of said line by driving piles to mark the location of the wall permanently. Such sea-wall shall be built in accordance with the plan marked B, hereto annexed :

Provided however, that in the line of said wall an opening, or openings, may be left for a dock, or docks, of such width, dimensions, and construction, as the Harbor Commissioners shall approve, which opening or openings shall be filled temporarily by bulkheads constructed in such manner as the Harbor Commissioners may prescribe.

The trench for this sea-wall shall be excavated under the direction, and to the satisfaction of the Board of Harbor Commissioners, from twenty-three to twenty-five feet in width at the bottom, which shall be as nearly as practicable a level surface. The depth

of the trench shall be at least twenty-three feet below mean low water and always to hard bottom.

The wall to the height of one foot below low water shall be built in quarry-face dimension stone of granite, laid in courses of two feet rise each by the aid of submarine divers. The courses shall be laid alternately entirely with headers and stretchers, the bottom, or first course, being headers. Each stone shall be at least four feet, and not more than ten feet long, at least eighteen inches wide, and exactly two feet rise. The wall shall be compactly laid in a substantial and workmanlike manner with fair and close outer face. Stones shall be laid so as to break joints everywhere, with good and sufficient bearing upon the beds without pinnars. The front face of the wall shall have a batter of four inches to the foot, and the rear of the wall shall be perpendicular. The base of the wall shall be eighteen feet, the height of the wall to one foot below mean low water twenty-two feet, and the thickness of the wall at this level eleven feet four inches. The wall from one foot below mean low water to the top of the coping stones or grade sixteen, shall be laid with dimension stones in cement. The courses shall be laid with headers and stretchers, and have two feet rise, with the exception of the coping course, which shall have a rise of three feet and be entirely of headers. The stretchers shall be at least four feet long, and the headers shall not be less than five feet long from the face inwardly. The spaces, however, back of the stretchers and between the headers, may be filled with quarry stones of large dimensions, laid compactly in cement, so as to form solid masonry. The front batter of the face shall be four inches to the foot. The base of this wall shall be nine feet, eight inches, the height, seventeen feet, and the thickness at the top of the wall five feet. The ends of all the sections of the wall shall be faced up in the manner above required.

And said party of the second part may, along the line of sea-wall to be built by it, but within the exterior line shown on the plan annexed to the second annual report of the Harbor Commissioners, construct, maintain, and use for wharf purposes, a suitable platform not to exceed fourteen feet in width outside of the top of such sea-wall.

And said party of the second part for the considerations aforesaid further covenants and agrees with said party of the first part, that it will within six years from the first day of October, A.D. 1869, unless, for good cause shown the Harbor Commissioners, with the consent of the governor and council, shall extend said time, fill

all of the said parcel of lands and flats herein before bounded and described, in the manner following :

The filling shall be to grade thirteen with dredged material, and said material shall be dredged from the trench to be made for the sea-wall herein before described, and from the area shaded red as set forth on the plan annexed to the second annual report of the Harbor Commissioners, and shall be deposited in such localities as may be designated by the Board of Harbor Commissioners, provided that material may be taken from other portions of the harbor of Boston for such filling, with the assent of the Board of Harbor Commissioners and the governor and council ; and upon the request of said board, and governor and council shall be so taken, after the area shaded red shall have been dredged out to the required depth. The area shaded red, and all other portions of Boston Harbor where dredging shall be authorized for filling as aforesaid, shall be dredged to such depth, and in such sections as may be directed by the Harbor Commissioners, but no portion of the same is to be dredged to more than twenty-three feet below mean low water. But said party of the second part shall, whenever required by the Board of Harbor Commissioners, fill on any portion of the westerly line of said parcel of flats, simultaneously with the progress of or after the filling or other occupation there on the easterly line of the westerly adjoining flats, conveyed by said Commonwealth and the Boston Wharf Company to said Harvey, Whitney and Groves. The sections in progress of filling shall be wholly or partially enclosed by said sea-wall and by temporary bulkheads to the satisfaction of the Board of Harbor Commissioners. The dredged material must be deposited to grade thirteen, and so soon thereafter as is practicable, the territory thus filled must be raised to grade sixteen by filling with clean gravel or other material, to the satisfaction of the Harbor Commissioners and the governor and council ; but nothing herein contained shall be construed to require said Boston and Albany Railroad Company to remove any ledge of rock that may be found in dredging outside the limits of the flats to be conveyed to said company as aforesaid.

And said party of the second part for the considerations aforesaid, hereby covenants and agrees with the party of the first part, that it will fill up as aforesaid that portion of the flats to be conveyed to said party of the second part, upon which the party of the first part shall locate Northern and Eastern Avenues, and the extension or continuation of B Street as herein provided whenever required by the Board of Harbor Commissioners with the assent of the gover-

nor and council, and that whenever the Commonwealth by its Harbor Commissioners, or otherwise, shall authorize the filling of the flats on the easterly line of said parcel herein before described, and the work of such filling shall begin, the said party of the second part will fill the flats on such easterly line, so far and at such time as the Harbor Commissioners may prescribe for the protection of the filling of the adjoining territory.

It is further agreed between the parties hereto, that when said territory shall have been filled as herein provided, the same shall be surveyed by the engineer of the Board of Harbor Commissioners, and said price of four hundred and thirty-five thousand six hundred dollars to be paid for said flats as herein provided shall be increased or diminished at the rate of twenty cents per square foot, according as the number of feet exclusive of Northern and Eastern Avenues and the extension of B Street over said territory, shall be found more or less than fifty acres, and the amount so found due the party of the first part, if any, shall be paid by the party of the second part in cash, with interest, if any shall have accrued, or in case the price shall be found less than four hundred and thirty-five thousand six hundred dollars, then such price shall be reduced to that extent, or the same and such interest as shall have been paid thereon shall be refunded to said party of the second part, or credited as a partial payment of its bonds as the case may require.

And said party of the first part hereby authorizes the said party of the second part to enter upon said parcel of flats, herein before bounded and described, and hold possession of and use the same when filled, so long as it shall keep and perform its said covenants and agreements herein contained and no longer, but in case of default therein on the part of said party of the second part, the said party of the first part shall have authority by its Board of Harbor Commissioners, subject to the approval of the governor and council, forthwith to enter upon said land or flats, and resume possession of the same, and do and perform at the expense of said party of the second part, everything which said party of the second part is bound hereby to do and perform upon and in relation to said land or flats, and said party of the second part hereby agrees to pay to said party of the first part upon the conveyance of said flats, in addition to the price aforesaid, ascertained in the manner aforesaid, any and all expenses which the said party of the first part shall so incur.

In testimony whereof the said Commonwealth of Massachusetts has hereunto affixed its seal by the hands of its Harbor Commissioners who have subscribed their names hereto, and the said Boston

and Albany Railroad Company has hereunto set its corporate seal by the hand of its president, thereunto duly authorized by the vote of the directors of said company, a copy of which is hereto annexed.

COMMONWEALTH OF MASSACHUSETTS, [SEAL.]

By JOSIAH QUINCY,

S. E. SEWALL,

DARWIN E. WARE,

F. W. LINCOLN, Jr.,

J. N. MARSHALL,

Harbor Commissioners.

THE BOSTON AND ALBANY R. R. CO.,

By C. W. CHAPIN, *President.* [SEAL.]

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK, ss. Then personally appeared C. W. Chapin, president of the Boston and Albany Railroad Company, and acknowledged the above to be the free act and deed of the said corporation. Before me,

MOSES KIMBALL, *Justice of the Peace.*

BOSTON AND ALBANY RAILROAD COMPANY.

At a meeting of the Board of Directors in Boston, December 8, 1869, the contract between the Boston and Albany Railroad Company, and the Commonwealth of Massachusetts through the Harbor Commissioners, for the purchase and filling of fifty acres of land of the South Boston Flats, having been read and considered, it was—

Voted, That the president be and he is hereby authorized to execute the same for and on behalf of this corporation.

A true copy from the Record.

Attest:

J. A. RUMMILL, *Clerk.*

COUNCIL CHAMBER, BOSTON, Dec. 8, 1869. The foregoing contract is this day approved by the Governor and Council.

OLIVER WARNER, *Secretary of the Commonwealth.*

Commonwealth of Massachusetts.

OFFICE OF THE HARBOR COMMISSIONERS, }
BOSTON, May 6th, 1869. }

To the Hon. CHARLES R. McLEAN, *Chairman of the Joint Standing Committee on Harbors.*

The Bill entitled an "Act authorizing the Fitchburg Railroad Company, the Boston and Maine Railroad Company, and the Eastern Railroad Company to widen their bridges over Charles River, upon certain conditions," having been referred by the Harbor Committee to this Board, the following Report upon the same is respectfully submitted:—

In the early part of the session the Fitchburg Railroad Company and the Boston and Maine Railroad submitted evidence to the Railway Committee which satisfied that committee that these railroads required a large increase of the width of their bridges on both sides of Charles River. It was, however, insisted by this Board, before the committee, that in case the railroads were permitted further to obstruct the waters of the river on its northerly shore, an equivalent for such privileges should be given in the form of an improvement in the draws and piers required for the convenient navigation of the stream, and giving a wider and less obstructed passage-way for the tide; and that for any encroachments on the Boston side of Charles River equivalents should be given in the reconstruction of the bridges so that the lines of piles should afford the least resistance to the flow of the tide, and conform to the plan earnestly recommended by the United States Commissioners in their reports on Boston Harbor.

The problem of obtaining proper equivalents for the extension of the railroad bridges on the northerly side of Charles River in increased facilities for its navigation, and the improvement of its water-ways, has already, after a most thorough investigation, been satisfactorily met by the Harbor Committee in its decision to require a widening of the draws to forty-four feet over Charles and Miller's Rivers, and an improvement in the position of these draws, and of the piers connected with them.

The problem upon what terms the railroads can be safely per-

mitted further to encroach upon the waters on the south side of Charles River, is met by the present bill.

This question does not derive its immediate importance from its commercial relation to the navigation of Charles River, but from its physical relation to the tidal system of Boston Harbor. The proposition of the bill is to bridge over the whole water-space from the Eastern Railroad bridge to Warren Bridge southerly of the line of draws over Charles River, by one continuous pile structure in the deep water of the channel. It is proper to say that the extent of this proposition is due to the suggestion of this Board. The Board were unwilling to entertain for a moment a proposition for any substantial encroachment on the unoccupied waters of Charles River on the Boston side which was not made inseparable from a reform in the existing bridges. A partial occupation would not furnish a sufficient inducement to the railroads to make the desired reform. The consequences of a partial occupation without this reform would be only added evil and injury to the harbor of Boston.

While the Board were unwilling to consent to further occupation in this locality without a proper reconstruction of the old bridges, it was still a subject of most serious consideration upon what specific terms it would be safe to consent to such an occupation; and we were glad to seek in the settlement of this question the aid of the United States Advisory Council, whose mastery of this class of questions is unrivalled. Their report upon the subject is appended. It is exhaustive in thoroughness, most comprehensive in scope, and entirely satisfactory. It is given in reponse to the following inquiry from the Board:—

“Should these railroad bridges south of the line of draws be taken up, and the pile work be re-driven in proper lines, and these lines be continuously extended from the east side of the Fitchburg Railroad bridge to the west side of the Eastern Railroad bridge, as they are now located, what would be the resistance to the water flowage, and the physical action of the tidal currents in passing through these new pathways compared with the unnatural pathways which the water is now forced to pursue?”

“In other words, which will be the least objectional structure, physically considered in relation to the harbor,—the present detached structures as they now exist, or a continuous structure, conforming, as proposed, to natural lines?”

It appears that the council have not merely examined the ques-

tion upon what conditions this limited occupation on the south side of Charles River could take place, but upon what conditions the whole space of the river from Cragie's Bridge to Charles River Bridge can be occupied by pile structures without deterioration to the harbor. They find that this occupation can take place by piles arranged in bays of not less than eighteen feet width, sheathed from the bottom to the level of high-water, in lines that shall offer the least resistance to the current, and an improvement obtained upon the present condition of Charles River, within the limits described, of thirty per cent.; and they authorize us to draw the inference that the occupation proposed in this bill, if made according to the conditions of the problem they have solved, will yield a proportionate gain.

While the council warn us against counting confidently upon this gain as a practical result, on account of the difficulty of securing in constructed works the exact counterparts of the elements of a mathematical computation, and make this a ground for insisting upon the required conditions of occupation without any abatement, they have no doubt whatever that the occupation can take place upon these conditions without detriment to the harbor.

Compliance with these conditions will involve an expenditure of a hundred or a hundred and fifty thousand dollars; but the railroads on the other hand will respectively gain thereby large tracts of territory of great value to them.

With the conditions above mentioned specifically inserted, the Board have no objection to the bill.

The Board would call the attention of the committee to chapter one hundred and seventy-six of the Acts of the year 1861, in connection with this subject, and recommend the repeal of this Act. It provides for the leasing or sale by the governor and council of a portion of this territory to the Boston and Maine Railroad, or Eastern Railroad Company, with a right to occupy it with pile structures upon the wholly inadequate condition that the new piles shall be "driven in extension of the present lines of piles." In this way an existing evil would be increased. The continuous pier for which provision is made in the bill is in the interest of the convenient navigation of Charles River, and, in the opinion of the Board, a valuable feature.

In conclusion, we would embody the views of the advisory council and this Board by proposing the following amendment to the present bill: Add after the fourth section the following sections in place of the present fifth section:—

SECT. 5. The foregoing rights are granted upon the following

conditions, namely: that all the work shall be done under the direction and in conformity with plans approved by the harbor commissioners; and further, that neither of said corporations shall have or claim any rights, nor do any work, under the provisions of this act until it shall (in such form and with such security as the board of harbor commissioners, subject to the approval of the governor and council, may require,) enter into an agreement with the Commonwealth to change the lines of the piles of its present bridge over Charles River southerly of the draws, so that they shall conform to lines to be determined by the harbor commissioners, in such directions that the piles shall offer the least resistance to the flood and ebb streams; and to enlarge the bays between each line of piles to not less than eighteen feet, and to sheath said line of piles from the bottom of the river up to the level of high water.

SECT. 6. Chapter one hundred and seventy-six of the Acts of the year eighteen hundred and sixty-one is hereby repealed.

JOSIAH QUINCY,
S. E. SEWALL,
DARWIN E. WARE,
F. W. LINCOLN, JR.,
WILLIAM MIXTER,
Harbor Commissioners.

REPLY OF THE UNITED STATES ADVISORY COUNCIL
TO THE QUESTION PROPOSED BY THE BOARD OF
HARBOR COMMISSIONERS.

GENTLEMEN :—§ 1. In the report which we made to your honorable board in the autumn of 1867, and which appears as an appendix to your Second Annual Report, we showed, from critical comparisons of several hydrographical surveys, that large changes had taken place in the bed of the upper harbor, and that these changes indicated a *shifting* of material from point to point rather than any considerable additions of deposits from external sources.

Moreover, it appeared that in some degree the ancient characteristic features of the harbor bed were disappearing—that shoals were forming where depressions formerly existed, and *vice versa* ; so that we were led to the conclusions that a change in the regimen of the physical forces of the harbor had taken place, and this change had been brought about by the artificial encroachments upon the pathways of the tides and currents.

§ 2. Among the multitude and variety of the encroachments that have been made since the date of our earliest minute survey, it is difficult to define the injury done by any single structure, especially as its influence often extends to a considerable distance, and perhaps in several different directions ; but, by combining the results of our comparisons of surveys with those reached in the physical study of the forces at work, we are able to substantiate charges against certain groups or classes of structures, and among these we find the bridges of the Charles River and Fort Point Channel.

To these bridges, built with an "*independent contempt for the free passage of the tidal streams,*" our predecessors, the United States Commission repeatedly solicited public attention.

In their Fourth Report (1861)—the first one published after the commencement of the physical survey—the United States Commission use the following language :—

"The bridges over the Charles River are not arranged with suitable reference to the natural flow of the currents, and it frequently happens that the momenta of the streams are destroyed by encounters with the piers and piles of the bridges and adjacent wharves. There is reason to believe that the river current, in the absence of the bridges, would distribute its deposit gradually, as its velocity slackened in its progress towards the sea, instead of throwing it

down in abrupt piles, as now. The ebb and flood tidal currents, approaching from nearly opposite directions, are differently deflected by the artificial structures, so as to complicate their relative paths and make it impossible to lay down a uniform rule for future structures in different portions of the estuary, as each case of a future structure must be a special one, and have relation to those already established in the neighborhood.

“There are some localities where the building out of the river banks would improve the course of the stream, and there are other points where permanent stone walls now interfere with its course.

“The current at any point of the channel is moving, not only with an action due to the local influence of gravity, but also with the power accumulated at points higher up the stream. Of these two elements the momenta is the conservative power—that which equalizes the depths of the water-ways and gives uniformity to the channel. It is this particular element of power which may be destroyed by bridges and open piling across the channel, which, although they suffer all the water to find its way through, do nevertheless produce much mischief. Among the railway bridges over the Charles River the utmost confusion is observable in the course of the tidal drift—its unity of movement is destroyed; it is local in character. To vessels towing through these bridges, the abrupt changes in the directions and velocities of the currents between the draws is a source of delay and vexation.”

In their Seventh Report, page 33, occurs the following:—

“If it be admitted, and we do not dispute it, that the conveniences of business are to be purchased at a price, and that price a certain degree of injury to the harbor, it must also be admitted that the limits of gain and loss, of advantage and disadvantage, ought to be as nearly balanced as possible. But we are now obliged to declare that these limits have been transcended in a hazardous degree, and we earnestly invite you to review and reform the whole subject of encroachments by bridges.”

And in the appendix (mainly devoted to the bridges of the Fort Point Channel) the following reference to Charles River is made:—

“That the construction of the bridges has much more to do with the reversion of the natural order of tidal heads than the general contraction of the channel, is made evident by comparing our tables. The tide of the Navy Yard has also passed through contractions at

the Castle Island Narrows, and at the city, yet the order of the tidal heads has suffered little disturbance.

“My examinations of the Charles River, recently made, confirm what I have stated most positively. I placed one gauge on the east side of the lower Charlestown Bridge, another on the east side of Craigie's Bridge, and a third in the basin above the West Boston Bridge. On these simultaneous observations were made, and a comparison of heights instituted. Between the first and second gauges there were six bridges in a space of 0.44 miles, between the second and third there were two bridges in a distance of 0.54 miles. The mean hourly variation of water level between the first and second gauges was found to be 0.25; and between the first and third gauges, 0.35. These figures give us the following ratios:—distances as 6: 13.4.; bridges as 6: 8; tidal heads as 6: 8.4.”

From the Tenth Report we extract the remarks given below:—

“The mere fact that *eleven thousand piles* have been driven into the channel-way of the Charles River near its mouth, without the least regard to anything but personal or corporate interests, would lead any reasonable mind to presume that some sacrifice of the usefulness of the stream must have occurred, and that this sacrifice is much larger than it need be.

“The present cross-section at one point in the Charles River is not so small as greatly to obstruct the tides, but the reduction of water-way is nevertheless serious. The bridges are built upon rows of piles placed nearly at right angles to the roadways. If a road crosses the stream diagonally, these piers also stand obliquely, and diminish the water-way considerably more than they would if parallel to the course of the stream, and this without materially lessening the cross section. In this case, the obstruction deflects the stream and introduces therefore angular resistance. The fact that the piers themselves are of open piling does not mend the matter, for in passing through the small opening eddies are created;—we have not only diminution of water-way and angular resistances, but we have also abrupt obstacles by which local heads are created which break up the continuity of flow.

“We suggest that as these bridges are repaired, their piers should be set in the line of current, and that they should be sheathed and so built as to present sharpened prows to the drift or stream from above or below, and the number reduced by the constructing engineers to the extent of their abilities. The frequent alterations of section caused by the bridges will (however perfect may be their

construction) cause some meandering of the stream, which the sheathing is suited to correct in part. The presentation of abrupt obstacles may be wholly prevented by the sharpening of the piers we have suggested."

And from the appendix of the same Report the following :—

"In the second table, that of the Charles River, we observe very much the same conditions that we have described for the Fort Point Channel; with this significant peculiarity, *the principal deflections of the axis occur in the lower reach where the bridges are most numerous.* Between Stations 1 and 2 the distance is 0.44 miles, and between 2 and 3, 0.54 miles. In the former, the deflection reaches a maximum of 13 minutes, in the latter, only 3 minutes. In these distances the half-tide sections, in the averages, do not differ much, while the perimeters differ widely, but are greater for the upper reach. It is plainly shown, then, that section and perimeter are not elements that need to be considered in the comparison."

But it is principally in their tenth and last report as the result of a final discussion, that they insist upon a radical change in the construction of the bridges.

§ 3. They suggest that as the bridges are repaired, the number of piers, or pile rows, supporting the structures should be reduced so as to admit of broader bays; that these piers or pile rows should be placed in directions conforming to the proper course of the stream, and that they should be sheathed. We accept and endorse this suggestion in its entirety, for although it embraces three operations of unequal importance, we hold that they are inseparable.

The resistances offered by these bridges to the tidal streams are principally those of abrupt obstruction due to piles and other timbers. To place these piles, were it possible, in exact conformity to the natural direction of the current, would not be to destroy, but simply to lessen the resistance which they offer. Each pile would still be an abrupt obstacle, and the stream, alternately enlarging and contracting its section in passing through the bays, would still suffer a decided loss. But if, in addition to giving proper directions to the piles, the piers are sheathed and sharpened, their character as abrupt obstructions disappears. Sheathing, however, by augmenting the surface exposed to the stream, gives importance to another element of resistance, otherwise inconsiderable, viz., friction. To keep this within proper bounds, we must reduce the number of piers.

§ 4. As the basis of our computations of the probable effects likely to follow from the additions and changes which you propose to make among these bridges, we have selected the following tables of observed data from the Report of the Commissioners on Harbors and Flats, dated February, 1866 :—

Tidal Heads in Charles River and Fort Point Channel.*

In Charles River.

Heights at Charlestown Bridge, minus Heights at Cragie's Bridge.				Rise and fall equal for this date, 2d Sept., 1863.	Heights at Cragie's Bridge, minus Heights in Charles River Basin.			
Hour.	Head of Flood.	Hour.	Head of Ebb.		Hour.	Head of Flood.	Hour.	Head of Ebb.
0	.00	VI.	.02		0	.00	VI.	+.01
I.	.07	VII.	— .16		I.	.07	VII.	— .08
II.	.26	VIII.	— .33		II.	.09	VIII.	— .12
III.	.49	IX.	— .30		III.	.02	IX.	— .18
IV.	.38	X.	— .44		IV.	.24	X.	— .12
V.	.28	XI.	— .44		V.	.02	XI.	— .08
VI.	.02	0	00		VI.	.01	0	+.03
Mean,†	.25		— .28			.07		.10

Fort Point Channel.

Heights at Lower Central Railroad Bridge, minus Heights at Dover Street Bridge.				31st, Aug., 1863. Mean head for six hours of flood, . 0 30½ For ebb, . . 0.31
Hour.	Head Flood.	Hour.	Head Ebb.	
0	0.00	VI.	+.00	
I.	+.07	VII.	— .12	
II.	+.26	VIII.	— .28	
III.	+.60	IX.	— .35	
	+.69		— .43	
IV.	+.60	X.	— .57	
V.	+.30	XI.	— .52	
VI.	+.00	0	— .01	

That these *tidal heads* are the measures of resistance due almost exclusively to artificial obstructions, is so clearly proven by the arguments that accompanied them in the report of the United States Commissioners, that it would seem unnecessary for us to add

* The observations were made by the Coast Survey, under very favorable circumstances and with great care. The data for the Charles River are from a tide somewhat in excess of the mean.

† Mean ordinate for six hours,

anything upon this point. Still we are tempted to offer one more illustration found in a comparison between the obstructed portion of the Charles River and a similar tidal channel remaining essentially in its natural condition, viz., Kill Van Kuhl.

Kill Van Kuhl is the principal communication between Newark Bay and New York Harbor. Like the portion of Charles River under discussion, it is a deep channel filling and draining a basin which receives a small supply of fresh water. The mean ratios of perimeter to section have not been accurately determined for Charles River; it is very evident, however, that the comparison would be unfavorable to Kill Van Kuhl, so that in neglecting these elements in the following table we do not invalidate our conclusion, but place it within the truth.

LOCALITY.	Area of Section.	Volume per Section passing Section. (Mean for six hours.)	Observed Head in 1,000 feet (Mean for six hours.)	Velocity per Section. (Mean for six hours.)
	Square ft.	Cubic ft.		Feet.
*Charles River, (from Cragie's } Bridge to Charlestown Bridge,) }	11,400	18,182	0.10	1.6
†Kill Van Kuhl,	43,398	134,534	0.03	3.1

It being granted that Kill Van Kuhl represents the orderly conditions of a channel without transverse obstructions, we may from its elements compute the measures for resistance that would obtain in the Charles River if the bridges were absent. With the ratios of section and perimeter equal, the mean tidal heads should vary with the square of the velocity at least; in other words $(3.1)^2 : .03 = (1.6)^2 : 0.008$, which would show that the artificial obstructions in the Charles River have increased the resistances twelvefold!

§ 5. As we have stated in § 2, "it is difficult to define the injury done by any single structure," and we may add, that to predict the effect of a local and partial change in the mode and extent of an encroachment, would require a much more intimate knowledge than we can gather from a study of the data at our command. It is only by assuming that the work you propose is part and parcel of a general scheme of reconstruction, and then by basing our calcula-

* The section just below Charlestown Bridge is the one used. The volume was ascertained from a survey of the whole tidal prism.

† The section used here is the mean of four representing the true mean very closely for a channel so nearly uniform. The velocity is observed, and the volume computed from it.

tion upon the features of this scheme in its ultimate form, that we reach positive conclusions deserving your confidence. We have premised, then, that the channel at its narrowest reach, just below Charlestown Bridge, is to be divided by sheathed walls, each eighteen inches thick, into water-ways of eighteen feet each, and that these water-ways are to be extended, without further reduction of section, to Cragie's Bridge. The surveys furnish us with *distances, areas of section, tidal heads and tidal volumes*, and our problem is reduced to the following question: Will the tides, rising and falling in Boston Harbor, fill and drain the Charles River, through our supposed water-ways, without necessitating an increase of the present *heads*—that is to say, without involving greater resistances than now appear? This question we are able to answer in the affirmative. The mean of our computed velocities for the flood is 2.14 feet per second, and for the ebb 2.28 feet per second.* The requisite mean velocity for filling and draining the Charles River tidal volumes through our supposed section is however only 1.90 feet per second; our computed velocities are therefore in excess, and the result of the change would be to lessen the mean head (according to rule of § four) about thirty per cent. for either flood or ebb.

To recapitulate: Our answer to your final question is this: *If the entire portion of Charles River between Cragie's and Charlestown Bridges were divided into forty-two water-ways, separated by sheathed walls, and each having the section we have used throughout, the ingress and egress of the tides would be attended with about thirty per cent. less resistance than now.*

In receiving this result we earnestly caution you against concluding that this thirty per cent. reduction furnishes you a safe margin for compromises regarding the extent of the sheathing or the width of the water-ways. Even if you are required to entertain the project before you, not as an improvement, but simply as one which shall not extend the present evils, we recommend you to insist upon the provisions of § 3. Because in practice so many errors of workmanship must occur, that an exact realization of a computed result is not to be expected. The history of hydraulic works illustrates too frequently the truth of this remark. Again, we have supposed an absolute continuity of the sheathed walls which may never be conveniently provided, and we have supposed an entire and not a partial control of the stream, while your project admits of a mixed order of old and new structures. We have besides

* We omit the lengthy computations by which we have reached these results.

taken no account of the tidal volume of Miller's River, which, although small, must be provided for ultimately. And, lastly, we have supposed that all broken piles, timbers transverse to the stream, and other hidden obstructions, will be wholly removed.

We add to this Report a series of tables and diagrams,* not before published, which represent the horizontal movements of the tidal currents among the bridges. They are from actual observations, and exhibit so much confusion in the drifts that we have refrained from placing any interpretation upon them, preferring that the reader should observe how far they justify the assertion already quoted from the U. S. Commission, that the bridges are built with an "independent contempt for the free passage of the tidal streams." We ought to mention, however, that the different localities were not observed upon simultaneously; so that comparisons between different diagrams must not therefore be too critically made.

We recommend to your honorable board to repeat and elaborate these observations, so that you may be able, after the proposed changes are commenced, to watch their developing effects, and improve every favorable feature. To this end we offer the following suggestions.

1st. Place a tide staff on the draw pier, below Charlestown Bridge, and another above Cragie's Bridge. These stations to be occupied whenever observations are in progress in any part of the intermediate space.

2d. For a single day, at period of mean tides and quiet weather, have observations of tides made on the extremities of the draw piers on either side of each bridge.

3d. Upon the ebb tide, at the third hour after high-water, throw over from Cragie's Bridge, at four different and equidistant points, a number of floats, and observe the times and places of their passing each bridge. Repeat similar observations for the flood, commencing at Charlestown Bridge, at the third hour after low water.

4th. Finally, take the bridges severally, and endeavor to measure the heads and *mean* velocities of the currents between and under them from at least four equidistant points by simultaneous observations.†

You will observe that operations 1 and 2 are designed, in addition to their immediate and obvious objects, to furnish the means

* The diagrams were not printed, on account of the expense.

† The determination of *mean velocities* referred to in 4 involves observations of currents of different depths.

of reducing to the same basis the observations of different dates and tidal hours referred to in operations 3 and 4.

Operation No. 1 involves the employment of two persons who shall be confined to observations at their stations and not available for other duties. Twelve additional observers may be sufficient for operations 2, 3 and 4. Fourteen persons directed by your engineer and his assistant may be expected to execute the entire project, together with the incidental questions that may arise, in about a fortnight of summer weather.

In the previous experience the use of boats was found less convenient than stationing men upon the bridges and having them signal each other.

An inquiry into the outflows and inflows of Miller's River has never been made, although tidal stations have been occupied in the basins above; we recommend that this inquiry be added to those we have heretofore suggested.

A. A. HUMPHREYS,

Bvt. Maj. General and Chief Engineer U. S.,

BENJAMIN PEIRCE,

Supt. U. S. Coast Survey,

HENRY MITCHELL,

Ass't U. S. C. S. in charge of Physical Surveys,

U. S. Advisory Council.

NOTE. On page 20 of the report, "Cragie" should be substituted for "the West Boston."

HARBOR COMMISSIONERS' OFFICE, CITY HALL, }
BOSTON, 15th January, 1870. }

HON. JOSIAH QUINCY, *Chairman of the Board of Harbor Commissioners.*

DEAR SIR:—I submit herewith a summary report of my duties as engineer to the Board, and of such field and office work as has been done during the past year, from the time of my connection with the Board, on the 26th of January, up to the 31st of December, 1869. In this report I state only the special matters referred to me by the Board for examination and report, and I am not able to enumerate all of these, as many questions have been responded to in oral reports while the Board has been in session.

The surveys which have been made, either by myself in person or by Mr. Koppmann under my direction and supervision, have been as follows:—

The determination and marking out of the line of the sea-wall inclosing the section of the South Boston flats conveyed to the trustees of the Boston, Hartford and Erie Railroad Company, and bordering upon Fort Point Channel and the inner harbor, first by a series of signals, and then by oak piles driven at every two hundred feet along the above-mentioned line. In driving these piles, the gins of the pile driver were brought exactly upon the line of the sea-wall, and the position of each pile determined by stations on India Wharf and Boston Wharf. This was a difficult and tedious operation, requiring several days of field work, and was executed between the 24th of August and 4th of September, 1869.

The lines of bulkhead, inclosing the deposits of filling upon the flats of the Boston, Hartford and Erie Railroad Company, were also determined by field observations, locating piles, and signals.

A determination by measurement and sketching has been made, partly by Capt. Loring (through the kindness of Gen. Foster) and partly by Mr. Koppmann and Mr. Curtis, of the present number and position of the piles under most of the bridges crossing Charles River between Boston and Charlestown. This was required in connection with the study and elaboration of plans for the new draws and other changes in the bridges required by law.

A series of borings into the bottom of the river have been made along the line of the West Boston Bridge, as a basis for the plan

and position of the new draw and piers required in widening the draw in this bridge.

Borings and soundings have been made, under the direction of General Foster, along part of the line of Atlantic Avenue, in connection with questions relating to the character and construction of the outer, or sea-wall, of this avenue.

A survey, and comparison with the coast survey of an early date, was made of the beach and lagoon inlet at the head of Holmes' Hole Harbor, at the request of the Legislative Committee on Roads and Bridges, in connection with questions of bridging the inlet.

Tidal observations and surveys have been made in Gloucester Harbor, in connection with questions referred to the Board by the Legislative Harbor Committee, concerning changes in the harbor line of Gloucester Harbor, and disputed wharf rights.

In response to various projects and questions referred to the Board by the Harbor Committee, and for other parties, I have made the following personal examinations and sketches.

2. Marblehead Harbor, for wharf construction, and for highway over tide-water requiring sea-wall.

1. Weymouth Fore River, for wharf construction.

1. Weymouth Back River, for wharf extension.

3. Salem Harbor, for city and street extension over tide-water; for wharf extension and for marine railway.

1. Buzzard's Bay, for causeway to Long Island.

2. Newburyport Harbor, for marine railway, and for bridge structures and piers.

2. Gloucester Harbor, for wharf extension and for harbor lines.

1. Wareham River, for bridge and harbor improvement.

1. Holmes' Hole Harbor, for wharf construction.

16. In Boston Harbor, for new draws and piers in Charlestown, Warren, Prison Point, Cragie's, West Boston, Broadway, highway across South Bay, Roxbury Canal, Fitchburg Railroad, Boston and Maine Railroad, Eastern Railroad, Lowell Railroad bridges.

Besides six actual surveys, making a total of thirty-six localities examined and surveyed or sketched.

In Boston Harbor, for wharf constructions, and for other structures, in South Bay, Fort Point Channel, at Boston Gas Company's wharves, and in Charles River basin.

Various other calls have been responded to, by reference to the archives of the office, concerning which no record has been kept.

Written reports have been submitted to the Board upon the following subjects, many of them requiring much time and study in

their preparation. In most cases plans and sketches have accompanied these reports.

Two reports, with large sketch, on draws and bridge improvement in Charles and Miller's Rivers.

Two reports, with large sketch, on draws and piers in West Boston Bridge.

One report, with sketch, on Roxbury Canal.

One report, with sketch, on highway across South Bay.

One report, on drainage of Stony Brook.

One report, on questions referred to Advisory Council.

One " with sketch, on South Boston Flats.

One " " on wharf in Weymouth Fore River.

One " " on causeway in Buzzard's Bay.

One " " on marine railway, Newburyport Harbor.

One " " on marine railway, Salem Harbor.

One " " on Collins' Cove, Salem Harbor.

One " " on Duxbury Bridge Co., Plymouth Har.

One " " on Phillips Wharf Co., Salem Harbor.

One " " on wharf in Plymouth Harbor.

One " " on floating boat-house, Charles River.

One " " on Gas Company's wharf, sea-wall.

One report, on areas of channels and flats, Charles River Basin and South Bay.

One report, on areas of channels and flats, Charles, Miller's and Mystic Rivers, and South Bay.

One report, with sketch, on wharf in Weymouth Back River.

One " " on sea-wall, Fort Pt. Channel.

One report, on Fitchburg Railroad lines for piles.

One report, with sketch, on wharf in Gloucester Harbor.

One report (in committee with Gen. Foster and Mr. Philbrick), on draws in Charles River Bridge.

One report (in committee with Gen. Foster and Mr. Philbrick), on draws in Charles River Bridge.

One report (in committee with Gen. Foster and Mr. Philbrick), on sheet piling in Charles River Bridge.

One report, with sketch, on road over beach, Marblehead Harbor.

One report (in committee with Gen. Foster and Mr. Mitchell), on bulkhead on South Boston Flats.

One report (in committee with Gen. Foster and Mr. Mitchell), on pile structure between Charles River and Fitchburg Railroad bridges.

One report (in committee with Gen. Foster), on sea-walls for Atlantic Avenue.

One report, on Charles River Bridge.

One " on South Boston Flats, excavations.

One " on Atlantic Avenue, compensation.

One " on draw in Eastern Railroad bridge.

One " on Wareham River.

One " with large plans (in committee with Gen. Foster and Mr. Mitchell), on Newburyport Bridge.

Many other minor statements and sketches have been prepared, which have not been made matter of record.

The duties of the office have required the constant employment and attention of Mr. Koppmann, and the following work has been executed:—

One large map (duplicate) of Lynn Harbor, showing harbor improvement (completed).

One large map, on vellum, containing topographical and hydrographical outlines of Charles and Miller's Rivers and the inner harbor, furnished at the request of the House Committee of the last Legislature on State Flats.

Two large plans, on vellum, of South Boston Flats, furnished to Governor and Council.

Eight smaller plans, furnished to Governor and Council.

One large plan, furnished to Boston and Albany Railroad Co.

Twelve plans, furnished to Boston and Albany Railroad Co., to accompany conveyances.

Thirty-four plans, prepared to accompany contracts with the Boston, Hartford and Erie Railroad Company.

Six plans, details of city bridges.

Two large plans, furnished to Harbor Committee.

Eighteen plans, various sizes, furnished to Harbor Committee, accompanying reports.

Much other work has been done appertaining to the office, of which no record has been made, and many of the plans specified have been drawn in duplicate, and even triplicate, where modifications have been required.

All the work executed by Mr. Koppmann, both in the field and the office, has been accurate and finely finished.

The duty of the Inspector of the Board, Mr. C. T. Curtis, during the term of his service, has been highly satisfactory. Mr. Curtis

has shown zeal and ability in the execution of all the work referred to him. He has made a daily report to the Engineer of the Board, embodying all the important details of his inspection and other duty.

Besides the matter above referred to, I would make mention of the many elaborate and important reports, upon bridge and other structures, presented by Gen. Foster, together with the many plans prepared under his personal direction; also of the reports of Mr. Mitchell, which have been given upon the most important subjects that have come before the Board.

Very respectfully submitted,

HENRY L. WHITING,

Engineer Harbor Comm'ers.

South Boston Plate
LIGHT SEA WALL.

South Boston Plate
HEAVY SEA WALL.

EAST BOSTON

PLAN

for the occupation of

FLATS OWNED BY THE COMMONWEALTH

IN
BOSTON HARBOR.

APPROVED AND ADOPTED BY THE GENERAL COURT.

by Chap. 81 of the Resolves of 1866,
AND MODIFIED ACCORDING TO CHAP. 354 OF THE ACTS OF 1867,
and Chap. 256 of the acts of 1868.

SCALE 10,000

Scale of feet

NOTE. Letters H & P and L & F in Commissioners Line B
referred to in different statements indicate the same points



MILLERS RIVER

RIVER

Granted in 1855

Boston & Lowell Rail Road Bridge
Boston & Maine R.R. Bridge

Boston & Lowell Rail Road Bridge

CHARLES RIVER

Boston & Lowell Rail Road Bridge

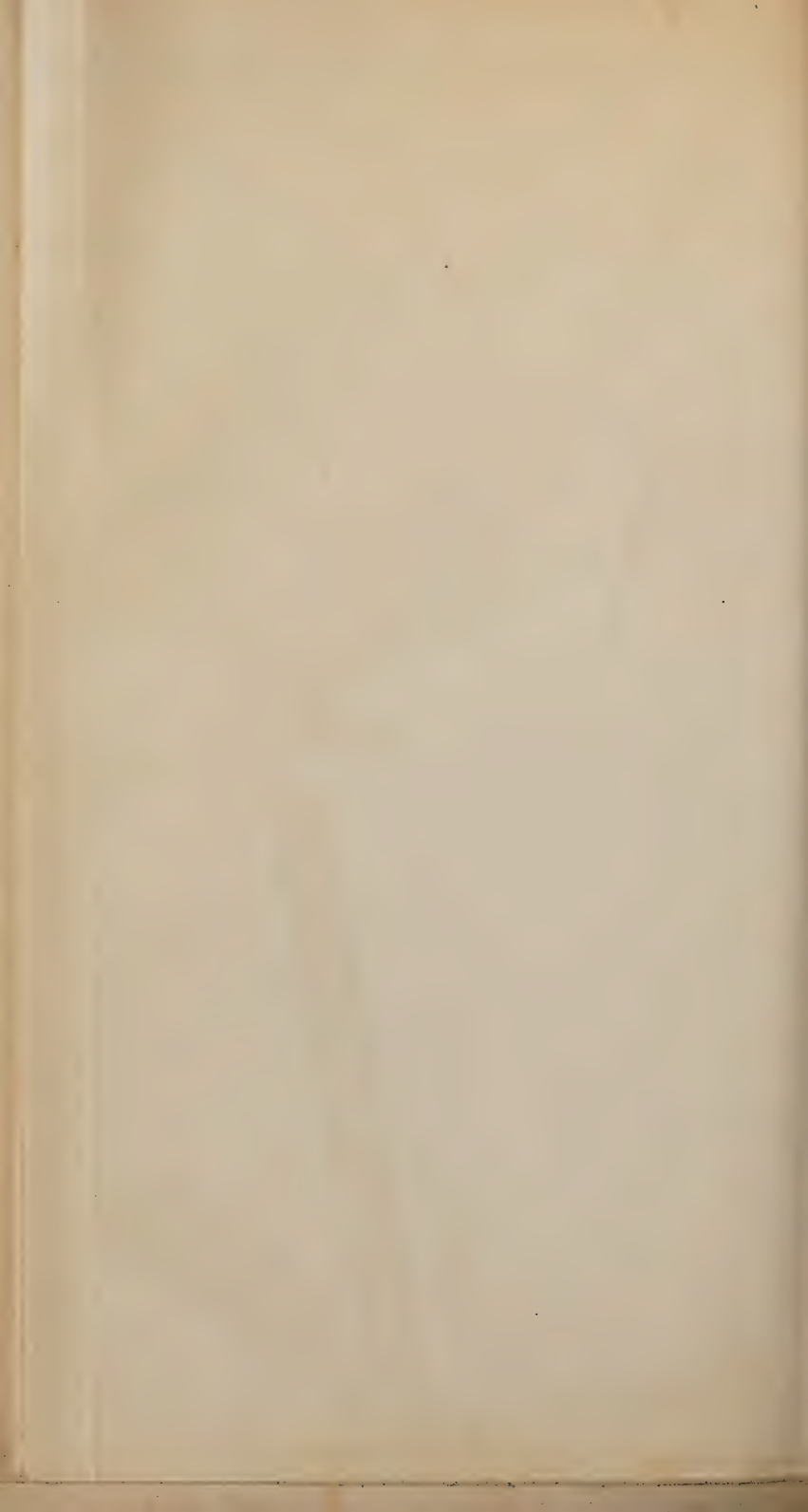
Charles Bridge

West Boston Bridge

CHARLES RIVER

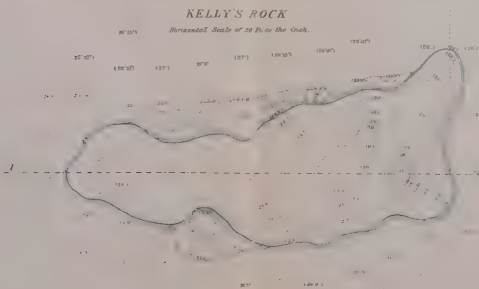
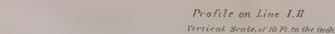
BOSTON

PLAN
showing
NEW LOCATION OF DRAWS
OF
CHARLES AND MILLER'S RIVERS,
as determined by the
BOARD OF HARBOR COMMISSIONERS,
WITH EXTENSION OF BRIDGES.
Authorised by Chapters 291, 311, 363 & 452 of the Acts of 1869.
Scale 200 feet to an inch.



at and below the NARROWS, and

showing progress made in the removal of said rocks by submarine blasting
under the direction of Bvt Maj Genl AG Foster, Lt Col of Eng^{rs}
in 1869.



At a Dredging Operations at SW Spu of Lovell's Island

Black broken line ... indicates high water line before dredging

After breaking bar It # curve before dredging

full " " " 18# curve in December 1869

Red heavy line — indicates rock wall built in 1861 & 1869.

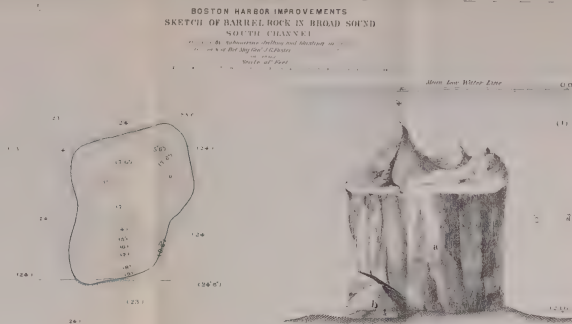
broken " " " " sea wall proposed to be built in 1879

At **C** Tower dock entirely removed by submarine drilling and blasting in 1966.

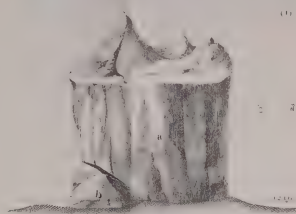
14. Corvin Rock removed to a depth of 23 ft, and more

at mean low water in 1967 and 1968

u. **Kell's** rock, taken in hand and removed to the
extent shown in sketch in 1869



Note
The main rock is a boulder of granitic gneiss, rest
is just a smaller detached piece of rock. &
Gladstone's estimate of rock = 115 cu yds = 2.12 tons.



FIFTH ANNUAL REPORT

OF THE

BOARD OF HARBOR COMMISSIONERS.

JANUARY, 1871.

BOSTON:

WRIGHT & POTTER, STATE PRINTERS,
79 MILK STREET (CORNER OF FEDERAL).

1871.

Commonwealth of Massachusetts.

R E P O R T.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts :

The Board of Harbor Commissioners respectfully submit their Fifth Annual Report.

SOUTH BOSTON FLATS.

On the 21st day of June, 1869, this Board, with the approval of the governor and council, sold to Messrs. Harvey, Whitney and Groves, trustees of the Boston, Hartford and Erie Railroad Company, 1,091,010 square feet of the State flats in South Boston, represented on the annexed plan by so much of the area colored green as lies north-easterly of the line X Z, for the note of the company for \$545,505, payable in twenty years and secured by a mortgage on the flats conveyed, subject to no other incumbrance. The residue of the area colored green, consisting of flats on the north-easterly side of Commissioners' line A and filled land on the south-westerly side of this line, the Boston, Hartford and Erie Railroad Company, through its trustees, had purchased of the Boston Wharf Company for \$1,350,000, payable in bonds on twenty years' time with interest, at seven per cent., to the amount of \$1,200,000, and a note for \$150,000 at the same rate of interest, payable in three years, secured respectively by mortgages back to Messrs. Pierce, Atkins and Morton, its trustees, and to the company. The mortgage to the Commonwealth covers, besides the tract granted by it, the tract pur-

chased by the trustees of the Boston, Hartford and Erie Railroad Company of the Boston Wharf Company, subject, however, to the two mortgages already mentioned, amounting in the aggregate to \$1,350,000. All these mortgages, the Commonwealth's and those of the Boston Wharf Company and its trustees, contain powers of sale and authorize the mortgagees and their assigns to purchase at the sales made under those powers. In order, however, to enable the legislature to have an opportunity to exercise the State's rights as a subsequent mortgagee and protect its interests, the Boston Wharf Company and its trustees bound themselves to give the State nine months' notice of any such sales under their mortgages.

The conditions of the mortgage to the Commonwealth provide not only for the payment of the note of the Hartford and Erie Railroad Company for the purchase money for the flats sold to it, but also for the construction, on the border of all its flats on Fort Point Channel and the Main channel, of a sea-wall and the filling of these flats under the direction of the Harbor Commissioners, in accordance with the terms of the company's contract with the Commonwealth. This work was to be completed within three years from the date of the contract (June 21st, 1869).

On the 8th day of December, 1869, this Board, with the executive approval, entered into an agreement with the Boston and Albany Railroad Company to convey to it fifty acres of South Boston flats adjoining those of the Boston, Hartford and Erie Railroad Company for \$435,600, payable in three years from October 1st, 1869. The company binds itself to fill these flats under the direction of this Board, and build in a specified manner a sea-wall on the line of these flats bordering on the Main channel, within six years, and is obliged to finish this work to entitle it to a conveyance.

Copies of the written instruments by which these transactions were consummated are appended to the report of this Board to the legislature of 1870, and reference is made to that report for more detailed information. Without making the contract of the Boston and Albany Railroad Company dependent at all upon the execution of that of the Boston, Hartford and Erie Railroad Company, it was the intention that each corporation should have three years in which to do its work, even if nothing was

done by the Boston and Albany Railroad Company before the work of the Boston, Hartford and Erie Railroad Company was completed.

The Boston, Hartford and Erie Railroad Company entered upon its work. It constructed on the south-easterly line of its flats an extensive bulkhead with a wing running westerly at right angles with this line, designed for the protection of the filling from the action of the currents; it partially excavated the trenches for the foundation of the sea-walls, and drove for about 410 feet the piles on which the base of the lighter of its walls was to rest, and partially built a detached section of the wall itself. In this work and in gravel filling inside of Commissioners' line A, the company expended, it is alleged, about \$100,000. This was all done in the latter part of the year 1869, and before our report for that year was submitted to the legislature. The insolvency of the company stopped the work, and nothing further has been done.

The present general condition of the territory and the structures mentioned is what might be expected to result from the suspension of the work. The bulkheads have suffered from the effects of storms and ice. The outer part on the south-easterly line of the tract of the Boston, Hartford and Erie Railroad Company has withstood these adverse influences better than the wing and is in a fair condition, only a small part of the planking having been torn off and the main structure being still firm and in position. The same cannot be said of the wing. More than half of the planking here has been torn off, and the whole structure is much dilapidated. At present it could serve but imperfectly the purpose of a temporary retaining wall. The material deposited by the Boston, Hartford and Erie Railroad Company within the inclosure of these bulkheads (amounting to about 30,000 cubic yards dredged from the trenches) has been washed down to a generally smooth surface, the highest part not being more than a foot or a foot and a half above the previous level of the flats. This indicates that the material is of a kind easily worked upon by the action of the water, and demonstrates the necessity of its inclosure to keep it from being swept by the currents into the channels and other sections of the harbor. The trenches dredged out for the sea-walls by the Boston, Hartford and Erie Railroad Company have

partially filled up again by the natural action of the water. In December, 1869, the trench for the heavy sea-wall was 400 feet long, 50 feet wide, had an average depth of 9 feet, and contained 6,667 cubic yards. A recent survey shows the trench to be 400 feet long, 40 feet wide, and on an average 8 feet deep, and to contain but 4,741 cubic yards, leaving a difference of 1,926 cubic yards, which represents the extent to which the trench has filled up since it was dug.

The trench for the light sea-wall along Fort Point Channel, in 1869 was 1,700 feet long, 15 feet wide, and on an average $4\frac{1}{2}$ feet deep, and contained 4,250 cubic yards. The recent survey of this work before mentioned shows a length of 1,550 (the residue having been filled up with wall and piles for the foundation of the wall), a width of 15 feet, and a depth of $3\frac{1}{2}$ feet, equal to 3,014 cubic yards. This shows a large filling, after allowing for the section occupied by the piles and wall.

RESUMPTION OF THE WORK.

The interests of the Commonwealth require that the work upon these flats should be resumed at the earliest moment practicable, and vigorously prosecuted. The occupation of the flats of the Boston, Hartford and Erie Railroad Company is a very desirable preliminary to the occupation of the flats sold to the Boston and Albany Railroad Company and of those of the State beyond; certainly a necessary preliminary to such occupation upon the plan that is best for the harbor and requires the least outlay in the construction of temporary retaining walls or bulkheads. Delay here tends to delay the whole improvement and to postpone the benefits that the State is to derive from it. What has been done so far has merely created dangerous obstructions in the pathways of vessels which will become more and more annoying and injurious, unless soon put to use in the resumed work of reclamation. Moreover, these fragments of work, which cost a considerable outlay and which will soon become worthless if abandoned, can, at a small expense, be made as serviceable as ever for the purposes for which they were intended. As the work, however, that has been done, excepting a portion of the trenches and a few piles driven to mark the line of the wall, has been done on the tract mortgaged to the trustees of the Boston Wharf Company, it can be made of service to the Common-

wealth only in the case of the redemption of the mortgages prior to its own, upon these flats.

Two courses to an early resumption of this work are open to the Commonwealth. It can foreclose its own mortgage by the execution of its power of sale, purchase the property at the sale and redeem these mortgages held by the Boston Wharf Company and its trustees, amounting to \$1,350,000 and the accrued interest, and itself do the work of reclamation at a cost for filling and walls, reckoned roughly on the basis of former estimates, of about \$1,500,000 more, and after the completion of the work, sell the territory thus acquired and reclaimed at its value in the market.

The area of this territory would be about three and a quarter millions of square feet. This would cost the State the amount of the two mortgages and the accrued interest, say \$1,450,000, and the expense of the sea-walls and filling, estimated at \$1,500,000 more, making a total cost of \$2,950,000. It would not generally be denied that the average market value of the whole tract after the reclamation and the establishment of connection with the city proper at the foot of Summer Street, by the construction of Eastern Avenue over Fort Point Channel, would not fall short of a dollar a square foot. Yet, upon this basis, a margin of profit would be left for the State. A dollar a foot, however, would probably, in the opinion of many persons of sound judgment in such matters, be regarded as too low an average for the price this property would bring on the conditions supposed. It is proper to assume that the estimated outlay substantially covers the cost of constructing Eastern Avenue over Fort Point Channel, as the mortgage for \$150,000 made by the Boston, Hartford and Erie Railroad Company was given merely as security for the construction of this bridge. An agreement was given by the Boston Wharf Company that this mortgage debt should be deemed satisfied and paid on the establishment of this connection with the city proper.

On the other hand it may be said, that while the outlay is certain and the ever accumulating interest account inevitable, the immediate market value of the result of the work, when accomplished, is at best but a matter of probability. The degree of that probability, different persons will differently

judge, according to their view of what is demanded by the growth of the city of Boston in the immediate future.

Whether, too, in this matter, the State should assume even the risks that a courageous man of business readily undertakes, will be decided differently by persons according to their view of the appropriate functions of the Commonwealth, and its ability to compete with private enterprise in doing this work at a profit. The Board urge the immediate resumption of the work, whether that resumption shall be undertaken by the Board on the basis of existing laws, which authorize the expenditure of no money from the treasury, or of an appropriation of money for the work, the Board leave to the wisdom of the legislature to determine, submitting such information upon the subject as is in their possession. The relation which the occupation of these flats on Fort Point Channel bears to the whole plan of occupying the State flats in South Boston, amounting to over 700 acres, is such that the prompt accomplishment of the work here is of quite as much importance as the mode of doing it, provided always the State sustain no loss.

The other course to an early resumption of work also requires an execution by the State of its power of sale under its mortgage and a purchase of the property, but instead of a redemption of the mortgages held by the Boston Wharf Company and its trustees, looks to the restoration of the Boston Wharf Company or some other responsible party to the ownership of the property covered by these mortgages, through an execution of powers of sale contained in them, and a purchase of the property either by the Boston Wharf Company or some other solvent purchaser. The coöperation of the owner of this property will be necessary to the State in occupying its own adjacent flats to the best advantage, inasmuch as the flats of the State should be inclosed by a continuation of the wall which must be built along the margin of its neighbor's tract on Fort Point Channel. The Boston Wharf Company's trustees have already made an entry to foreclose their mortgage upon this territory. They could regain their title by executing the power of sale contained in their mortgage after three weeks' notice and buying in the property at the sale. They are restrained from this immediate recovery of their property by the agreement with the Commonwealth to give it nine months' notice of the sale, to

enable the legislature to have an opportunity to decide whether the State shall exercise its right of redemption. If the State is not to exercise this right, it is for its interest to waive the right to this long notice and permit the Boston Wharf Company and its trustees to make an immediate sale. The sooner the Boston Wharf Company can be invested with the title to the property it sold to the Boston, Hartford and Erie Railroad Company, the sooner the State will have a responsible party ready and anxious to act with it in carrying out this long cherished improvement. With the Boston Wharf Company ready to proceed with the work upon its flats after regaining the title to them, with the Boston and Albany Railroad Company bound to fill fifty acres lying on the south-easterly line of the flats of the Boston Wharf Company and of the State, the Board believe there can be no difficulty in procuring, on sufficiently favorable terms, a contract for the occupation of the twenty-five acres that will belong to the State, forming on the annexed plan the corner between the Main and Fort Point Channels, and so resuming this work during the present year. The Board accordingly recommend the legislature:—

1. To give immediate authority to foreclose the State's mortgage by the execution of its power of sale, and to authorize the purchase of the property covered by the mortgage in the name and behalf of the Commonwealth.

2. To determine whether or not the State will exercise its right of redeeming the mortgages to the Boston Wharf Company and its trustees, with a view to acquiring the whole title to the property covered by these mortgages, and improving this property from its own treasury.

3. To make an appropriation, if this question is decided in the affirmative.

4. If this question is decided in the negative, to waive the nine months' notice the Boston Wharf Company and its trustees must now give the State before they can sell under their mortgages.

THE FLATS OF THE BOSTON AND ALBANY RAILROAD COMPANY.

The Boston and Albany Railroad Company has deposited upon its flats about 162,067 cubic yards of material, dredged

from its docks in East Boston and the harbor near the entrance to them. In accordance with the contract of the company, this is not to be reckoned on account of the thirteen feet to which the flats are to be filled with material dredged from that part of the harbor represented by the area colored red on the annexed plan, but on account of the additional three feet (making a grade of sixteen feet in all), which the company has the right to fill with gravel.

PURCHASE OF SOUTH BOSTON FLATS.

The purchase of the tract of flats in South Boston represented in blue on the plan, and situated between B and E Streets, 220 feet distant from the north-easterly line of First Street, has been substantially consummated by the Board, according to the anticipations expressed in its last report. Three undivided eightieths of what is called the "Fan Piece," measuring $163\frac{21}{100}$ feet on First Street, and four undivided sevenths of a parcel measuring 165 feet on the same street are the only interests in that tract that the State has not acquired. The owners of three of these sevenths indicate their willingness to sell on the terms the State has paid to other owners, but too late to complete the transaction before the close of the year when the appropriation expired. The Board therefore request the legislature to renew the appropriation to the amount of twenty thousand dollars, that the whole of this outstanding title may, if possible, be purchased, but certainly the three sevenths whose owners are now ready to sell to the State. The appropriation originally made (chap. 446, Statutes 1869) was \$300,000, of which but \$229,049.95 has been expended. The area acquired amounts to about 2,159,000 square feet, and by this purchase the State is relieved of any real or imagined obligation to maintain a channel-way in front of the South Boston shore in carrying out its plan for the occupation of its own flats beyond. The area of this channel reservation, 805,000 square feet, should be added to the amount actually purchased to obtain the area the State gains by this transaction for occupation. The State assumes the obligation of reserving from its flats a street fifty feet wide, and of filling it to grade with First Street whenever the whole adjacent area between B and E Streets, 220 feet wide, shall also have been filled to that grade. The riparian

owners are already taking measures to fill this space. When this is done it will be for the interest of the State to have some portion of these flats it has bought, besides the street, either filled or sold subject to the obligation of building the street. Whichever course shall at the time seem most advantageous to the State, the Board, subject to the approval of the governor and council, will pursue. In order that the Board may contract for or require of a purchaser, filling on the terms obtained by the shore owners, some legislation will be required that will relieve such portion of these purchased flats as are to be filled soon, from some of the provisions of law applicable to section one of the annexed plan.

In making this purchase of flats the following deeds have been approved by the Board and governor and council, and accepted by the Board :—

William H. Story and *al.* to the Commonwealth, dated March 14, 1870. Consideration, \$3,300.

Mary Kelly to the Commonwealth, dated August 25, 1870. Consideration, \$3,300.

Susanna C. Johnston to the Commonwealth, dated June 8, 1870. Consideration, \$3,300.

Osborn Howes *et al.* to the Commonwealth, dated March 23, 1870. Consideration, \$15,796.62.

Joseph T. Bailey and *al.* to the Commonwealth, dated March 14, 1870. Consideration, \$4,573.24.

Daniel Denny *et ux.* to the Commonwealth, dated March 18, 1870. Consideration, \$75,170.

Caleb W. Loring, trustee, to the Commonwealth, dated March 18, 1870. Consideration, \$10,391.04.

Caleb W. Loring, guardian, to the Commonwealth, dated June 21, 1870. Consideration, \$649.44.

Caleb W. Loring, guardian, to the Commonwealth, dated June 21, 1870. Consideration, \$649.44.

Jacob Sleeper and *al.* to the Commonwealth, dated March 1, 1870. Consideration, \$17,406.35.

Seth Adams to the Commonwealth, dated March 1, 1870. Consideration, \$3,223.40.

William S. Eaton to the Commonwealth, dated March 2, 1870. Consideration, \$1,934.04.

Barker B. Kent to the Commonwealth, dated March 1, 1870. Consideration, \$17,406.35.

William B. Dodge to the Commonwealth, dated March 1, 1870. Consideration, \$3,223.40.

Samuel S. Perkins to the Commonwealth, dated March 1, 1870. Consideration, \$6,446.80.

Frederick Nickerson and *al.* to the Commonwealth, dated March 16, 1870. Consideration, \$8,400.

Samuel K. Williams to the Commonwealth, dated March 16, 1870. Consideration, \$5,355.

Henry A. Rice and *al.* to the Commonwealth, dated March 18, 1870. Consideration, \$1,166.67.

Edward E. Rice and *al.* to the Commonwealth, dated March 18, 1870. Consideration, \$1,166.67.

George Woods Rice to the Commonwealth, dated March 16, 1870. Consideration, \$1,855.

Henry A. Rice to the Commonwealth, dated March 16, 1870. Consideration, \$1,166.67.

Barker B. Kent to the Commonwealth, dated April 20, 1870. Consideration, \$8,207.50.

Alpheus Stetson to the Commonwealth, dated March 24, 1870. Consideration, \$1.

Alpheus Stetson, guardian, to the Commonwealth, dated April 29, 1870. Consideration, \$507.50.

Sarah C. Brooks and *al.* to the Commonwealth, dated March 21, 1870. Consideration, \$3,038.67.

William B. Brooks to the Commonwealth, dated March 26, 1870. Consideration, \$7.25.

Micajah Pope to the Commonwealth, dated February 28, 1870. Consideration, \$15.

Charles B. Bedlington and *al.* to the Commonwealth, dated March 16, 1870. Consideration, \$2,677.50.

Charles C. Conley to the Commonwealth, dated March 16, 1870. Consideration, \$3,552.50.

THE DRAWS ON CHARLES AND MILLER'S RIVERS.

In the early part of the past year the work was finished of building a new draw and widening the draw-way in the Charles River Bridge to the width of forty-four feet. This was done in accordance with the legislation of the year 1869, which required all the draws in the bridges over Charles and Miller's Rivers to be widened to forty-four feet and placed in such position as the Harbor Commissioners should determine, the object being to secure an alignment of the widened passage-ways so that vessels

might go through them in a straight instead of a zigzag course. The new draw works admirably. It causes a detention of travel of but about seven minutes for every vessel passing through under average conditions. Every expectation the new draw at this point was intended to meet has been fully and satisfactorily answered by the commissioners having charge of the work.

The Fitchburg Railroad Company entered promptly upon the work of widening the draw in its bridge, and only waited for the cessation of navigation in the winter which the construction of the draw would obstruct, to comply fully with the requirements of the law. A renewal of the discussion of this question in the legislature led to still further delay.

The Boston and Maine, Eastern, and Lowell Railroad Companies exerted themselves to secure a large reduction of the width prescribed by the statutes of 1869. All these railroad companies, as also the Fitchburg, had been applicants for the privilege of making extensive encroachments on the flats and water areas of Charles River, already excessively encumbered, and the duty of reconstructing their draws to the width of forty-four feet in proper position was imposed upon them as a compensating benefit to the harbor and to navigation which they ought in fairness to perform. The Fitchburg Railroad Company began at once both to occupy its grants and to widen its draw to the required width. The other companies, having obtained the privileges they had applied for, preferred to concentrate their energies upon securing a reduction to the lowest terms of the obligations imposed upon them, and succeeded in getting a law passed reducing to thirty-eight feet the width of forty-four feet that had been previously prescribed. At this stage of the proceedings the aldermen of the city of Boston, for the first time intervened in their capacity, as they declared, of "surveyors of highways," and the opinion was expressed that the widening of the draw-way of Warren Bridge to thirty-eight feet would involve the removal of the water pipe across Charles River at a cost of \$10,000, and that thirty-six feet was in their judgment a sufficient width as a passage-way for vessels. It was perhaps questionable whether the water pipes of the city, or the passage-way for vessels on Charles River, although part of what is called "the highway of nations,"

were within the jurisdiction of the board of aldermen as surveyors of highways. The opinion too that a width of thirty-six feet would be less of an interference with the water pipe, than thirty-eight feet, proved to be erroneous, and the water pipe to be one not in use. This intervention, however, was the occasion for an attempt still further to reduce the width of the draw-ways, and in the last days of the session a bill was introduced and enacted, requiring not merely the draw in Warren Bridge but all the draws that were to be reconstructed on Charles and Miller's Rivers, ten in number, to be built thirty-six instead of thirty-eight feet wide.

There is a satisfactory ground on which the reduction of the width first established for these draw-ways can be maintained, and the Board are glad to believe it to have been the real one; that ground is the conviction that all these railroad bridges must in a short time be reconstructed or a new way devised for the railroads to cross Charles River that shall be less obstructive to navigation, and injurious to the harbor of Boston, and therefore such temporary provision as can be made to answer the immediate demands of navigation until this radical reform takes place is deemed sufficient. An Act passed by the same legislature that made these successive reductions in the width of the proposed draw-ways, providing that the Railroad and Harbor Commissioners should, if possible, submit to this legislature a comprehensive and feasible plan for improving, at the same time, the navigation of Charles River and the terminal facilities in Boston of the railroads entering the city on the northern side, indicates that such considerations had a controlling influence. Both boards acting together as a joint commission have given this subject a great deal of attention and will submit their results to the legislature in a joint report.

This Board has given the line of the new draw-ways on Charles River to the Fitchburg, Boston and Maine, Eastern, and Lowell Railroad Companies, and approved the respective plans of all except the last, for constructing the draws under the law requiring a width of thirty-six feet. No work, however, has been done upon them since last winter. The construction of the draw of the Fitchburg Railroad Company will temporarily obstruct navigation, and the month of February of this year, this being the month during which there are

scarcely ever any vessels passing, has been prescribed by the Board as the time for doing this work. The railroad companies whose plans have been approved, have had notice from the joint Commission of Railroad and Harbor Commissioners that plans were entertained by them which, if approved and adopted, would involve further changes in their bridges and draws, and this fact may have led to delay on the part of the railroad companies, that would not otherwise have occurred.

LOCATION OF DRAW IN WEST BOSTON BRIDGE.

Upon the application of the mayors of Boston and Cambridge, who were made by the legislation of last year, *ex officio*, Commissioners on the West Boston and Cragie Bridges, the Board has revised the location of the draw in the West Boston Bridge made in 1869 and described in its last report. The bridge commissioners represented that the difference in cost that would be made by the change in location, judging from actual proposals received for the work, would amount to twenty thousand dollars, and they wished to avoid so large an expenditure. The reason of the Board for giving the new draw a new location, was the fact that, directly opposite the south-westerly opening of the present draw-way there is quite a serious shoal. A new survey and a comparison of its results and those of the last previous one by the U. S. Commissioners in 1861, showed some changes in this general ground which confirmed the judgment of the Board in their objection to this locality, in its present condition, as a site for the proposed new draw. The shoal has assumed a more abrupt bank on its northern end and has extended northward until it now overlaps the draw-pier, so that within the passage-way and some 80 or 90 feet above the end of the pier there is now but six feet of water where the survey of 1861 gave nine feet. It appeared also that the cost of removing this shoal would not much exceed \$5,000, and that once removed it would in all probability either not form again or form very slowly. The Board accordingly, to save expense, revoked the former location and consented that the present location should remain, on condition that the shoal should be first dredged away and that such action should be taken that the depth of the water thus secured should be maintained. It is doubtful whether the bridge commissioners

have under the statute authority to do this dredging and maintain the depths of water so obtained. That this doubt may be removed the Board desire that the requisite authority should be given by the legislature.

COMPENSATION ASSESSED FOR ATLANTIC AVENUE.

After due notice to the city of Boston this Board, on the 29th day of June last, passed a vote requiring the city to pay into the State treasury, in accordance with the provisions of sect. 2, chap. 324, St. 1867, and sect. 4, chap. 149, St. 1866, the sum of \$61,663.46 as compensation for tide-water displaced by the construction of Atlantic Avenue. The vote was immediately transmitted through the mayor to the city council of Boston, but no notice has been received by the Board of any action upon it. They learn, however, from the newspapers, that at the close of the last municipal year the city council instructed the mayor to apply to the legislature for relief from this assessment. From the report of the city committee recommending the passage of this order, it appears to have been their impression that since the city was authorized in 1867 to construct Atlantic Avenue, subject to the obligation of making compensation for tide-water displaced by the structure, investigations had been made by the advisory council of the Harbor Commissioners that had led them to abandon this principle, and that consequently the reason for making these assessments having failed, the law requiring them should be repealed and the city relieved from this particular application of it.

No public hearing upon this subject was given by any committee of the city council, and no opportunity of explanation was afforded to this Board or the engineers whose supposed opinions seem to have been made the ground of action. The Board, however, is glad to believe that the legislature has only to intimate its desire that the law under which Atlantic Avenue was built should be complied with and the city authorities will cheerfully pay this assessment into the treasury of the State. For this reason no further steps have been taken for its collection.*

That there may be no question in the mind of any one what

* Mr. Quincy being an abutter and interested under the betterment laws, adversely to the assessment, has taken no part in the action of the Board on this subject.

the judgment of the advisory council is upon this subject the Board have submitted to the council the following inquiry, and will at once transmit to the legislature their report in reply, as soon as it shall be received :—

“ *Voted*, That the advisory council be requested to state to the Board their judgment as to the importance and expediency of applying the principle of compensation to the upper harbor of Boston, as prescribed in sect. 4 of chap. 149 of the Acts of the legislature of Massachusetts for 1866, and whether and to what extent any investigation made since the reports of the United States commissioners to the city of Boston, and particularly the investigations mentioned in the report of the advisory council to this Board appended to the report of this Board to the legislature of 1868, have modified the basis upon which the principle of compensation has been maintained.”

SOUTH BAY.

The Roxbury Gas Light Company has made application to this Board for a revision of the harbor lines of South Bay in Boston. This is the only formal application upon this subject, but it has come to the knowledge of the Board that many owners of flats in this locality have desired such action and the revision will be made. Although the present lines were established no longer ago than the year 1864, still, within a few years the navigation on these waters has greatly increased, the lands bordering upon them have risen in value and been very rapidly occupied for business purposes dependent upon such navigation, and it is desirable that as much territory here should be surrendered for occupation as is consistent with the wants of navigation and the maintenance unimpaired of the physical function which South Bay performs in its relation to Fort Point Channel. Great changes also have, since 1864, been made in the bay by the location through it of the solid embankment of the Boston, Hartford and Erie Railroad. Were there no other reason for such revision, the serious errors in the text of the statute of 1864 would make a reënactment of the law necessary.

WAREHAM RIVER.

During the past year the Board have had made a careful survey of Wareham River, with a view to the establishment of

proper harbor lines and the determination of the causes that have led to the formation of shoals near the wharves. They also have it in mind to apply to Congress for the removal of the bar that has formed at the mouth of the river, should the results seem to justify such action. The great importance of this port and the extensive manufactures carried on there, call for a serious effort to improve the navigation of this river, upon which the prosperity of the place almost wholly depends.

CAPE COD CANAL.

Although the Cape Cod Canal is the project of a private corporation, it is nevertheless a project for the construction of a great work of immense importance to the commerce of the country, and especially that of Massachusetts. It has long been a cherished scheme of the people of this Commonwealth. The company received its charter and franchises from the legislature with every evidence that the company had its earnest wishes for the success of the enterprise. On obtaining its charter, the company applied to Congress for aid in the construction of a breakwater in Barnstable Bay, to serve as a protection for the terminus of the canal and a means of obtaining safe temporary anchorage for vessels intending to pass through. The legislature gave its weighty sanction to this application. Regarding this work as peculiarly of that class for which the Board is authorized by the law establishing it, to apply to Congress for aid, it presented the memorial appended to this Report.

The action of the committees of both branches of Congress upon this application of the company was entirely satisfactory. The measure enlists there the hearty support of the senators and representatives from the Commonwealth, and no doubt is entertained of its final success. The company represent that as soon as the coöperation of the national government in the manner stated is secured, it is ready to proceed at once with the work.

WOODS' DAM.

The Board on the 1st day of August last, upon the application of citizens of Medford and its selectmen, caused an information to be brought in the supreme judicial court against B. F. Woods of Arlington, to prevent him from re-constructing and

maintaining a dam on the Mystic River in connection with his mill. For the last nineteen years there has been a standing controversy between the proprietor of this dam and the citizens of Medford, concerning the rightfulness of this structure. As often as it has been torn down by one party it has been replaced by the other, with such demonstrations of excitement and ill-will as continually to endanger the peace of the Commonwealth. In 1862 the City of Charlestown built in this locality, under authority of the legislature, and in connection with the establishment of its water works, tide-gates, which, by agreement with that city, Mr. Woods was permitted to use, in consideration of the removal of his dam. By the statute, the governor and council were authorized to remove these tide-gates whenever they saw fit, in case they were not removed by the city, and in 1867 the governor and council exercised this authority, and the gates were removed by the constable of the Commonwealth under executive order.

Thereupon Mr. Woods rebuilt his dam. In the season of boating on the river, citizens of Medford and the vicinity have from time to time, to a greater or less extent, removed the dam, and it has been rebuilt, and last summer, when the Board intervened, the dam had been torn down by a large concourse of citizens interested in maintaining the boating upon the river. The grounds upon which the legality of this dam is contested are :—

1. That it is an unauthorized structure in tide-waters flowing into Boston Harbor.
2. That it is an intrusion upon the bed of the stream, which is the property of the Commonwealth.
3. That it obstructs the public right of boating on this river.

A hearing has been had upon the facts, and the case is to be reported to the full bench. It is believed that a decision will be obtained before summer that will set at rest all questions of right now in dispute.

RECLAMATION OF THE GREEN HARBOR RIVER AND NORTH RIVER MARSHES.

The interest that has been taken by the inhabitants of Marshfield in the drainage of the marshes of Green Harbor River, and

of the inhabitants of South Scituate in the drainage of North River, and the counsel sought by them in regard to these subjects, has, during the past year, opened to this Board a new field for service of the highest utility.

Last winter the county commissioners of the county of Plymouth obtained authority from the legislature to construct a bridge across Green Harbor River, which, under the laws of the Commonwealth, is to be exercised in a manner approved by this Board. It was the desire of many citizens of Marshfield that the new bridge should be so located, and that such a structure should be built as might serve at the same time the double purpose of a highway, and be used in the construction of a transverse sluice for draining the marshes of the river. Having received notice that when the question of the location of the highway arose, the claim would be asserted that this location should be fixed somewhat with reference to the drainage of these marshes, it became necessary for the Board to investigate the expediency and feasibility of the project.

It was an essential part of the plan for reclaiming the marshes on North River that a sluice dam should be constructed, which would keep out the waters of the ocean during flood tide, and during the ebb drain off the waters of the river. Such a structure would obstruct navigation, and require the sanction of the legislature, and to obtain this sanction the Board were desired to favor the undertaking. To do this, it became necessary in this case also, to investigate the expediency and feasibility of the project.

The marshes upon Green Harbor River comprise about fifteen hundred acres, and those of North River about three thousand more. They produce nothing but the least valuable of the grasses that grow on salt marshes. Reclaimed they would produce English hay or garden vegetables. These reclamations would benefit all the towns upon these rivers, and restore to some the prosperity which was theirs when they were centres of business that has since left them for the suburbs of great seaports. A generation or more ago, North River was devoted to ship-building. Some of the best ship-builders in the country obtained their early training in the yards on this stream. Not a vestige of them remains. The navigability of this river for the class of vessels that used to be built upon its banks was

destroyed some years ago by inroads of the sea breaking through the natural shingle dike that separated its lower reach from the ocean and filling up the channel. An attempt afterwards to dig a new outlet through this dike failed utterly, and all hope of making this river again usefully navigable has long since been abandoned.

The magnitude of the interests involved in these projects was manifest. To obtain observations and calculations for the determination of the practicability of the drainage of these marshes by sluicing, the Board had recourse to Prof. Benj. Peirce, Superintendent of the U. S. Coast Survey, and obtained the heartiest coöperation in the proposed measures; inasmuch as all questions affecting the navigability of tide-waters are peculiarly within the province of his department.

Prof. Henry Mitchell, who is a member of the U. S. Advisory Council to this Board, was authorized to make the requisite observations and calculations for determining the practicability of the proposed projects.

Prof. Henry L. Whiting, who acts as engineer of this Board, was authorized to carry inland, as far as the marshes extended, the survey that had formerly been made of the coast at the outlet of North River, and make some additions to the existing coast survey maps of Green Harbor River.

These officers called for volunteers for this work, and they were promptly supplied by the Massachusetts Institute of Technology. The students gladly embraced the opportunity to take part in a work so practically useful, and to be so scientifically conducted. They brought to its aid the requisite acquirements and the true enthusiasm of engineers.

GREEN HARBOR RIVER.

Green Harbor River, regarded in its relations to the drainage of the marshes for agricultural purposes, by the employment of transverse dams and sluices is found to offer to the engineer no new problem, and the conditions to be fulfilled are so simple that complete success is sure to follow a faithful execution of works upon old and well-tried plans. In their relations to the harbor and its entrance, however, works of this character, it is believed, are not likely to remain neutral. Their effects must be considerable, because they will deprive the channel-way over the bar

at the entrance of the harbor, of a scouring power which now serves to maintain there a depth of about two feet of water at low tide. Professor Mitchell shows that the ebb stream executes at the mouth of the harbor eight times as much scour as the flood, and that in this way the sands which would otherwise invade the basin are pushed back into the sea. He concludes, therefore, that in the course of time, after the construction of the sluice dam, the bar channel will fill up to the plane of low water so as to convert the basin into an exclusively tide harbor like those of Scusset and Sandwich.

In regard to the value of this harbor Professor Mitchell uses the following language :—

“The lower reach of the river is known as Green Harbor, whose length from Turkey Point to the bar is about seven-eighths of a mile, and whose maximum low-water width scarcely exceeds five hundred feet. A sand-bar obstructs the entrance, upon which there is from two to three feet of water at ordinary low tide. The average rise is nine feet, and vessels can take the ground within the harbor, at low tide, without injury. The shelter from winds and sea is good. As far as I could learn the trade of the place employs but one small vessel, but during the summer many small yachts for the accommodation of watering people make here a rendezvous. It is not entitled to the slightest consideration as a port of refuge, although vessels have been known to run into it under desperate circumstances.”

Prof. Whiting reports upon this subject as follows :—

“As a small local harbor it also has some character. Once within the mouth of the river, a small vessel would find good anchorage, a sufficient depth of water and complete shelter. The entrance, however, is shoaler than the river within, and really cannot be called navigable at low water.

“Considered as a commercial port the whole available water is but of small extent.

“As a harbor of refuge, it will probably never be of use except by the local fishing boats and small pleasure yachts of the immediate neighborhood. For coasting vessels generally, or any craft seeking a harbor of refuge merely, the far more accessible and ample harbor inside the Gurnet, but a few miles southward, renders Green Harbor River of no value as a public refuge.

“It is questionable whether the construction of a dike and gates, by shutting off the upper reaches of the marsh creeks as a reservoir, will materially affect the river below them, or injure the entrance to it.

“But even if this should be the case, at some remote day the reclaimed marshes will be of far greater value to the local community and to the town, county and State, as an agricultural district, than any use which can be made of the unimproved waters of the river.”

It has, therefore, seemed to the Board that in comparison with the great benefits to the agricultural community that would result from the reclamation of the marshes, the probable effect upon the basin of this harbor was an inconsiderable matter, and that the public good in the premises plainly required that these benefits should be secured, although in the way that involves the least injury to this conflicting interest, slight as it may be.

Professor Peirce's very valuable “criterion for reclamation,” finds its first publication in this Report, and is applied to the case of the Green Harbor River marshes. That the projected reclamation stands the test of this criterion is shown in the following extract from Professor Mitchell's Report:—

“The marshes are nearly at the level of high water in this portion of the basin, and supposing at the date of our observations, gates to have been closed upon the river at the time of low water, the accumulation behind them during the following six hours would have been according to Professor Peirce's criterion about three feet, so that the surface of the marsh would have been six feet above the water table at the time of high water in the Bay. This depth of three feet is largely in excess of the fresh-water supply, because many of the creeks do not fully discharge their tide-waters during the fall in the main river. Our hydrometer at low-water gave a density of 1.095; indicating that the outflow was then three-quarters sea-water. Indeed the current observations show that the fresh-water discharge was exceedingly small, and that gates of ordinary dimensions may be relied upon for draining this basin perfectly.”

The question of the location of the bridge to be built across these waters has not been presented to the Board by the county

commissioners. In view of the importance of this reclamation, and the great saving of expense that would be secured if the location and construction of this bridge could be determined with reference to this reclamation, the Board recommend the consideration of the expediency of such a modification of the Act of last winter, that the construction of this new highway may be made of service to this great agricultural improvement.

NORTH RIVER.

On the other hand, North River presents physical difficulties in the way of reclamation, which have been subjects of very careful inquiries in the peculiar field of investigations with which Professor Mitchell is charged in his department, and in which he has won such distinction as an engineer. He has spared no pains to determine the practicability of drainage, and at the same time has considered the physical phenomena presented by the river mouth and adjacent portions of the coast with which the problem of reclamation in this case is intimately concerned. He concludes that in spite of the large fresh-water supply afforded at certain seasons, the reclamation of these marshes can be effected by the construction of a single sluice dam. But to insure entire success, the beaches of shingle and sand that lie between the marshes and the ocean should be made secure against inroads of the sea by the construction of dikes at several weak places. The height to which these dikes should be carried he is able to compute from the study of shingle levees here and elsewhere. His comments upon shingle levees, which in our country appear only upon the New England coast, shows that these objects, so familiar to our eyes, play an important part in the economy of nature, and are worthy of the study not only of the curious inquirer, but of the practical engineer.

Another class of observations has led Professor Mitchell to fix definitely the minimum height for the sluice-dam to provide against overflow from the "general rise" during storms. He has taken for his standard the vertical elevation observed in Boston Harbor during the Minot's Light-house gale, and from that calculated the lesser elevation that must have occurred upon the open coast and at the mouths of little streams like Green and North Rivers.

With regard to the rise of the water behind the proposed dam during the period that its gates must remain closed, a very close calculation is made, but the result is of course confined in its precise application to the period of his survey. He, however, indicates clearly the means that may be taken by a simple series of observations, for computing this element for other seasons, so as to ascertain exactly how much drainage must be provided for, in planning the sluice-gates.

The section of Professor Mitchell's report which, incidentally, to this problem, discusses the origin of tide marshes is a part of his general study of the coast in which he gives the results of his own experience and that of other engineers in physical hydrography. All testimony is found to concur in attributing to the waves of the ocean the most active part in filling up the sheltered coves and harbors of the coast, and yet it seems to be equally true that great bays and gulfs are pushing their way into continents.

Upon the point whether after drainage these marshes will not sink, Professor Mitchell obtained satisfactory evidence from those who attempted to make the new channel through the dike as an outlet for the river. He says :—

“I glean one curious fact from those employed in opening this channel, viz.: the original bank of shingle was found to extend downwards only to the surface of the marsh, which was not sensibly depressed beneath its weight. I infer that as Fourth Cliff wears away the whole beach falls back and the present banks of sand and shingle are really superimposed upon ancient meadow lands or river channels. The marshes are not floating bogs like the *koogs* of Denmark or liable to slump down after enclosure, like the *polders* of Holland. The newly formed levee, across the mouth of the artificial outlet exerts a pressure of over 1,200 pounds to the square foot upon the marsh beneath its crest, and the weight of the original bank as far as I can judge, was over 1,700 pounds to the square foot under the crest. I have allowed in these estimates 25 per cent. for voids. Old rubble breakwaters, that have been shaken down by the waves to a state of repose, occupy still a space 25 to 30 per cent. greater than the rock *in situ*. Some shrinkage will no doubt take place after drainage is effected, but this will not, I think, exceed 10 to 12 per cent. If the *water table* is dropped four feet, I shall expect the marsh surface to sink about six inches.”

The following are the general conclusions of Prof. Mitchell's study of the two projects:—

1. The marshes of Green Harbor River may be drained by the construction of a sluice-dam at Turkey Point without unusual precautions or expense, but not without injury to the present facilities for navigation below said point.

2. The North River marshes can be drained by constructing a sluice-dam at White's Ferry, provided the present obstructions below are removed by dredging; and provided, also, that dikes are carried across the "slue-ways" of the beach to the height of thirteen feet above mean high water of the sea.

3. The dams to escape overflows from the "general rise" during storms, must be carried at least four and a half feet above mean high water of the sea.

4. The marshes after drainage will not sink or shrink more than twelve per cent. of their elevation above the "water table."

The results of Professor Whiting's survey of North River are represented on finely executed maps, which, with the enlarged coast survey maps of Green Harbor River, are given in one of the plans in the Appendix on a much reduced scale. The original map of North River has been drawn on a sufficiently large scale to be serviceable in carrying out the contemplated improvement. Professor Whiting's very interesting report in the Appendix gives the results of a careful discussion of these points:—

1. The value of the inlet at North River as a harbor, of the river for commerce and navigation, and of the marshes for agriculture in their present condition.

2. The probability of the river ever becoming by natural causes navigable, or of any substantial change occurring in the character of the marshes.

3. The probability that this river or the inlet will ever be improved so as to be made of value again for ship-building or navigation.

4. The practicability and profit for agriculture of converting these salt marshes into fresh, drained meadows.

His conclusions on all these points are favorable to the proposed reclamation.

In view of these results the Board do not hesitate to recommend the passage of a law authorizing the construction of the sluice-dam on North River, requisite for the reclamation of its

marshes. When this has been built there should be some penal legislation to protect the shingle dike between Third Cliff and the mouth of the river from the practice that has heretofore prevailed of removing material from it to be used for ballast and paving stones. This dike will form the sole barrier of these marshes against the sea in storms, and will be necessary for the security of the improvement when once made. It becomes the muniment of a most valuable property and should have thrown around it all the safeguards of the law.

Authority also should be given for the occupation, subject to the approval of this Board, of so much of the beds of Green and North Rivers as may not be needed for drainage.

The Board is not aware that any reclamations of salt marshes have been made in this Commonwealth upon the large scale proposed in these plans for Green Harbor and North Rivers.

In Europe such reclamations are common. In Nova Scotia they have been undertaken with complete success. Very recently in New Jersey the drainage of the Newark meadows has been attempted, and the results thus far are full of promise and encouragement. There must be many thousands of acres of salt marshes in this Commonwealth that could be made to yield the most abundant and profitable harvests. These soils are of the richest character and worked with the greatest ease. They only need drainage and protection from inundation from the sea. In many cases these can be secured without too large an outlay for a handsome profit. Such reclamations are positive additions to the wealth of the State, and the Board is glad to be able to promote them.

GOVERNMENT WORK IN BOSTON HARBOR.

The work in Boston Harbor under General J. G. Foster of the United States Engineers, has made during the past year most satisfactory progress. Congress made an appropriation of \$100,000, which with the unexpended balances of prior appropriations has been used for the reduction of Kelly's Rock, the dredging away of the upper middle bar, the completion of a sea-wall around Gallop's Island, and the commencement of the sea-walls around Long Island and Point Allerton. These works in progress, together with others in Boston Harbor which have been completed during the last three years, comprise nearly all

that were selected by the United States Engineer Department as of pressing and absolute importance from the scheme of improvement presented and urged upon Congress by this Board in the first year of its organization. The appropriations thus far on this basis have amounted to \$516,000, and under the wise and efficient administration of the engineer department and of General Foster in charge of the work, they have been expended to the best advantage. The report of General Foster, with the map illustrating it in the Appendix, shows in detail what has been accomplished and what remains to be done. It is a document of great interest and value. It embraces in its scope an admirable statement of the beautiful adjustment of things through which Boston Harbor was made by nature one of the finest in the world, describes the rapid deterioration it underwent in consequence of the improvident sacrifice of great natural advantages for the sake of trivial gains, and by reason of the neglect of proper remedies, and demonstrates the necessity of all the measures that have been taken to arrest further decline. It conveys an impressive admonition not to imperil for the sake of immediate but not indispensable benefits the indispensable conditions upon which the maintenance of Boston Harbor and the vast interests connected with it depend, and inculcates the duty of transmitting to future generations, of larger expansion even than our own, this noble organ of commerce with the world.

GOVERNMENT WORK ELSEWHERE.

Other government works for the improvement of the harbors and navigable waters of the Commonwealth have been successfully prosecuted during the past season, under General Foster's charge.

In Newburyport Harbor the wreck of a coal schooner lying in the channel just inside the entrance, has been broken up by blasting and the fragments removed by divers.

At the "Lower Falls" in the Merrimack River a channel for canal-boat navigation has been excavated nearly through the rapids. The completion of this cut, and also a similar one through the "Upper Falls," will secure for the cities of Lawrence, Lowell and others on the river, the benefits of cheap water transportation in barges from Newburyport.

At Gloucester a survey of "Dog Bar," at the entrance of the harbor, and also of the rocks in the inner harbor has been made. In the former survey the Board has coöperated with a view, should the results justify such a course, of petitioning Congress for an appropriation for the improvement of this harbor, and the construction of a harbor of refuge at its entrance. An enlargement of the safe anchorage ground of this most important and enterprising port is greatly needed.

At Plymouth Harbor works have been constructed for the preservation of Long Beach similar to those recently applied with success for the preservation of Beach Point in Provincetown Harbor.

In Provincetown Harbor the construction of brush and stone protections for the exposed beaches, and dikes to check the rush of the tides through open reaches, has been extended so as to allay all apprehensions of further injuries at present.

At Hyannis the completion of the breakwater, by building up the upper courses, has been carried forward during the past, and is to be continued during the next season.

In the Taunton River operations were commenced for the removal of the shoals, which are met, at intervals, for a distance of three and a half miles below the city of Taunton. The machinery employed proving inadequate active operations were postponed until next season, when good progress is anticipated. This improvement is of material interest to the commerce of the city of Taunton, which will be much benefited thereby.

DUPLICATION OF THE UNITED STATES COAST SURVEY MAPS FOR MASSACHUSETTS.

The Board respectfully urges upon the attention of the legislature the considerations presented in the last report in favor of the duplication of the maps of the United States survey of the coast of this State.

The increasing demand for a better knowledge of the harbors and shores of the Commonwealth, such as accurate surveys alone can give, has made the want of such surveys outside of Boston Harbor, a serious embarrassment to the Board in their investigation of the subjects referred to them. The possession of the results of the Coast Survey would supply the needed data. Arrangements can be made with the superin-

tendent of the Coast Survey, and with his office, by which copies of the original maps can be obtained. This will give to the State, for the mere expense of copying, surveys that have cost the general government several hundred thousand dollars. Prof. Peirce, the superintendent of the United States Coast Survey, is willing not only to coöperate with the Commission in this undertaking, but urges its accomplishment as a measure of advantage and value to the government and to the State by providing *duplicates* of the original maps. The only record of these expensive and elaborate surveys is contained in the original maps, which are on a larger scale than any of those engraved and published.

The Coast Survey Department would favor any arrangement which would secure a duplication of these maps and their safe deposit in the archives of the various States; in fact, the practical execution of some plan effecting this general result has been for some time a matter of consideration by this department. Hardly any State bordering on the Atlantic has a greater extent of coast or more important harbors, in proportion to its territory, than Massachusetts, and, therefore, none is more interested in securing accurate knowledge in regard to them.

The number of the original topographical maps of the Coast Survey covering our State territory is between fifty and sixty. These are on the large scale of $\frac{1}{10000}$, or about six inches to the mile, and generally extend back from the coast line to the first shore road giving land communication from port to port. Added to these would be the in-shore hydrographical maps, which are fewer in number.

The copying of these maps will be a work of probably some two or three years, as it would not be desirable to organize a large office force to accomplish it in a more rapid manner, and all the maps could not be spared from the office of the Coast Survey, for this service, at one time.

The Board would be particularly favored in this work by the service of their engineer, Prof. H. L. Whiting, who is one of the senior officers of the Coast Survey and chief of its department of field topography.

We are unable at this time to give a detailed estimate of the cost of the entire work proposed, but will submit one should it

be required. In general terms, the following estimate is submitted:—

60 topographical maps, at \$200 each, . . .	\$12,000 00
40 hydrographical maps at \$150 “ . . .	6,000 00
Office and other incidental expenses, \$1,000 a	
year for three years,	3,000 00
	<hr/>
	\$21,000 00

One-third of this amount would be sufficient as a first appropriation, \$7,000 00

It is safe to state that the general government has expended, in its survey of the coast of Massachusetts, not less than \$500,000, the practical benefit and value of which can be possessed by the State government at a cost of but about \$20,000.

PROTECTION OF THE HARBORS OF THE COMMONWEALTH.

The Board also request some legislation, that shall enable it to protect more effectually, the channels and anchorage grounds of the harbors of the Commonwealth, from the practice of throwing ballast and other materials into them, which are of injurious tendency. Applications have been made to the Board to prevent such practices, and the Board is charged by law with the duty of preventing them. But more legislation is needed to make such practices clearly recognized and penal offences. Some such protection as the law gives Boston Harbor, should be given to all the harbors of the State, or the essential parts of them.

PLANS APPROVED.

The Board has approved plans, during the past year, for the erection of structures in or over tide-waters as follows:—

For the extension of the south pier of Lewis Wharf in Boston.—*Approved March 23, 1870.*

For the construction of a bridge over Mitchell's River at Chatham, by the County Commissioners of Barnstable County.—*Approved April 8, 1870.*

For widening and extending certain wharves in Gloucester Harbor, by David Low & Co.—*Approved April 8, 1870.*

For widening a wharf in Gloucester Harbor, by Dennis & Ayer.—*Approved April 8, 1870.*

For building a wharf on the south-easterly side of Albany Street, in Boston, by Joseph F. Paul.—*Approved April 15.*

For construction of pile wharves to the Commissioners' line in Boston Harbor, by the Boston Gas Light Company.—*Approved April 27.*

For driving piles in Fort Point Channel in Boston Harbor, in the reconstruction of Mt. Washington Avenue Bridge, by the City of Boston.—*Approved May 4.*

For the construction of a wharf in South Bay, Boston Harbor, to the Commissioners' line, by John W. Leatherbee.—*Approved May 4.*

For the construction of a wharf in South Bay, Boston Harbor, by A. R. Whittier.—*Approved July 6.*

For the extension of a wharf in South Bay, Boston Harbor, by Nathaniel Winsor.—*Approved July 6.*

For the construction of a bridge across the channel-way, connecting Lagoon Pond with the waters of Holmes' Hole Harbor, by the County Commissioners of Dukes County.—*Approved July 27.*

For the construction of a wharf in South Bay, Boston Harbor, by Seth Whittier and A. R. Whittier.—*Approved August 3.*

For filling solid Hosley and Russell's Wharf in Fort Point Channel, Boston Harbor.—*Approved August 24.*

For the construction of a bridge across Duck Creek in Wellfleet, by the Cape Cod Railroad Company.—*Approved Aug. 24.*

For the location and construction of a new bridge across Merrimack River, between Grovehead and Haverhill, by the County Commissioners of Essex County.—*Approved Sept. 1.*

For the location and construction of a new draw in the Boston and Maine Railroad bridge over Charles River.—*Approved Oct. 27.*

For the construction of a wharf in Weymouth Fore River, by Thomas J. Dunbar.—*Approved Dec. 14.*

STATEMENT OF ENGINEER AND OFFICE WORK.

The special surveys and other field work executed by the engineer, by order of the Board are as follows :—

In Hingham Harbor a survey has been made of a portion of the main channel with its surroundings, together with the examination of a rock in this channel, below the steamboat wharves. A copy of this survey with a statement of the condition of the river and the character of the obstruction caused by the rock above mentioned, was transmitted by the Board to the Chief Engineer of the Army, Gen. A. A. Humphreys, as the basis of an appeal to the general government to improve the navigation of the harbor by the removal of the rock.

In Charles River, or Cambridge Basin, so called, a detailed survey has been made of the shoal above or south of West Boston Bridge, near the location of the present draw.

A survey has been made determining the amount of solid filling over the original ground of the South Boston flats.

A survey has also been made of the South Boston flats proper, determining the changes and injuries which have occurred since the suspension of the work of building sea-walls and depositing material within the territory of the Boston, Hartford and Erie Railroad.

Field determinations have been made establishing the Commissioners' line in South Bay, along the front of the Boston Gas Works in Charles River, and for the extension of Lewis Wharf. The line of the draw-way openings through the railroad bridges over Charles River, has also been established.

An extensive and elaborate survey has been made of Wareham River from above the town and railroad bridges to the chops of the river at the head of Buzzard's Bay. The topography, hydrography and tidal observations embraced in this survey required a month of working time for a large field party. The purposes of this survey as the bases for a scheme of river improvement, have been already stated. The result, in the form of an elaborate map, with plans for harbor lines, will be made the subject of a special future report.

Field reconnaissance, examination and sketches have been made in Gloucester Harbor, in Weymouth Fore River, in Wellfleet Harbor and in South Bay in Boston Harbor and also of

the shingle dike in Scituate, and of North River, South River, and Green River.

In addition to the surveys made by direct order of the Board, they have coöperated in the surveys of the North River and Green River, made under the direction of Prof. Peirce, Superintendent of the United States survey by his assistants, Profs. Whiting and Mitchell, reports concerning which are appended to this Report.

In connection with these operations the Board visited the ground of the contemplated reclamation of the marshes of the North River, and met at North Marshfield several of the parties interested in this important improvement.

The Board have also visited the ground of the proposed Cape Cod Canal.

The office work executed during the year has been varied and continuous. The inquiry for data, and the information furnished to parties, public and private, who have interest in navigable tide-waters and harbor, river and coast improvements, show an increasing demand for the service and supervision of the Board, and the value of its archives.

At the solicitation of the Board, the data were furnished from the United States Coast Survey office at Washington, for an accurate duplicate of the large and valuable chart of Boston Harbor, made for the United States Commissioners by Mr. A. Boschke in 1861-2. Office work has been continued in the details of this chart and is still in progress.

The drawings, plottings and copy of the map of Wareham River, on a large scale, are also in process of completion.

Of miscellaneous office work the following plans and sketches have been made :—

Showing the location of new draws in Cragie

and Prison Point Bridges, 6 plans.

Location of draw in West Boston Bridge, 1 plan,

Location of draw in upper Lowell Bridge, 1 “

Location of draw in Boston and Maine and
Eastern Railroad bridges, 1 “

For Railroad and Harbor Commissioners, show-

ing bridges in Charles and Miller's Rivers, 1 large map.

Showing railroad terminal ground in Boston, Charlestown and Cambridge,	2 large maps.
Showing comparison of soundings between surveys by Messrs. Wadsworth and Boschke, . .	1 map.
Part of Hingham Harbor,	1 “
Copy from Registry of Deeds in Dedham, . .	1 “
Thompson's Island, showing limits of ground for the removal of gravel,	1 plan.
Spectacle Island, for deepening the approaches to Ward's Wharf,	1 “
For Roxbury Gas Light Company, showing Commissioners' lines in South Bay, . . .	1 “
Fender guard for fender pier of Broadway Bridge, over Fort Point Channel,	1 “
Atlantic Avenue Sea-wall,	1 “
Roxbury Canal, South Bay,	1 “
Part of South Bay, for Legislative Committee, .	1 “
For Railroad and Harbor Commissioners, showing boundaries of real estate in Cambridge, .	1 “
Showing estates between Lowell and Leverett Streets,	1 “
Showing estates between Causeway Street and Haymarket Square,	1 “
Showing filling on South Boston flats, . . .	1 sketch.
Showing trenches and sea-wall, South Boston flats,	1 “
Shoal above West Boston Bridge,	4 sketches.
Location of Rock in Hingham Harbor, . . .	1 sketch.

Numerous minor sketches and extracts from plans and charts furnished to various parties, have not been made matter of record.

ORGANIZATION.

The Board still avails itself of the counsel of General J. G. Foster, of the United States Engineers, in all matters of constructive engineering that come within the jurisdiction of the Board. Prof. Henry L. Whiting of the United States Coast Survey, with the consent of the Superintendent, acts as engineer of the Board, and has Mr. D. Koppmann as his assistant

in field and office work. Rear Admiral C. H. Davis, Gen. A. A. Humphreys, Chief of the United States Engineers, Prof. Benj. Peirce, Superintendent of the United States Coast Survey, and Prof. Henry Mitchell, chief of physical hydrography in the U. S. Coast Survey, aid the Board as an Advisory Council, especially in difficult questions requiring scientific investigation. By this organization the Board maintains intimate relations with the authorities of the United States, who have an official interest in the navigable waters of Massachusetts. The general government is thus enabled readily to appreciate the needs of the State, and the State to understand the wishes of the general government, and both to act in harmony for the public good.

JOSIAH QUINCY.
DARWIN E. WARE.
F. W. LINCOLN, JR.
J. N. MARSHALL.

JANUARY 10th, 1871.

A P P E N D I X.

MEMORIAL IN BEHALF OF THE CAPE COD CANAL.

[TRANSMITTED TO HON. JAMES BUFFINTON, MAY 19, 1870.]

To the Senate and House of Representatives of the United States in Congress assembled.

The undersigned, constituting the Board of Harbor Commissioners of the Commonwealth of Massachusetts, and charged with authority, among other things, to apply to Congress and in proper cases for the protection and improvement of the harbor facilities of the State; in pursuance of such authority in discharge of their duty, respectfully present the following memorial:—

From an early period after the settlement of the Plymouth Colony to the present time, the project of connecting the waters of Barnstable and Buzzard's Bay, by an artificial navigable channel, to avoid the necessity of making the long and dangerous passage around Cape Cod, has been much discussed and earnestly advocated.

In the investigation of this subject several elaborate surveys of a route have been made by private enterprise, and by the direction of the State and the nation. Every such investigation has resulted in a new demonstration, not only of the practicability, but the easy practicability of the project, especially when judged by the difficulties that have often been surmounted by individuals and governments to secure inferior advantages

of the same kind. Natural depressions formed by the valleys of the Scusset and Monument rivers, and extending across the isthmus, separating the two bays by a space about seven miles wide, together with a soil that shows an entire absence of ledges, and is not hard to excavate, furnish the most favorable conditions for the construction of the work.

The temperature of the waters of Barnstable Bay in winter is such as to make it reasonably certain that the navigation of the canal will not be stopped by ice in the coldest weather.

The saving in distance that can in this way be effected for vessels going by Long Island Sound to or from any port in Massachusetts Bay is about one hundred and forty miles, and two hundred miles for vessels going by the ocean route below the Sound. This saving in distance represents an annual saving of over six hundred thousand dollars in the cost of transportation.

Moreover, the passage around Cape Cod is an exceedingly perilous one. The wrecks of over a thousand vessels, and the loss of many hundred lives, bear witness to the dangerous character of this coast, and the ruin it has caused in only a single generation. This mere element of danger to navigation, by increasing the rates of insurance for voyages around Cape Cod, occasions a pecuniary loss to the commerce of the country in addition to that which results from the actual destruction of property. It would require to capitalize this annual loss in the form of a principal fund bearing an annual interest of six per centum, sufficient to compensate the loss, over three millions of dollars, a sum which would go far towards paying the cost of the canal.

In view of these facts, it is surprising that this work was not long ago undertaken and completed by the United States or by private parties. It is, however, easy to understand that the government might not be disposed to embark in the undertaking except upon a basis that would insure an income sufficient to reimburse to it the interest on its expenditures, and that it would be inclined to believe that upon such a basis it was a more suitable undertaking for private than for public enterprise.

On the other hand, the construction of the canal on the route that has found most favor involves a large expenditure for a

breakwater at the terminus on Barnstable Bay, which, though indispensable, requires for its construction the sinking of so much capital that does not contribute to the main work of the canal proper, that capitalists have naturally been reluctant to undertake to carry through a project encumbered by so heavy a burden. The appropriate solution of all difficulties in regard to the terms upon which this great work may best be undertaken, would seem to be found in a plan which should assign to private capital the part of building and working the canal, and to the national government the construction of the necessary breakwater in Barnstable Bay.

The Commonwealth has already given a charter to several responsible gentlemen, who command the confidence of the people of Massachusetts, to construct this canal, and the Cape Cod Canal Company established under this charter is ready, in the belief of the undersigned, to enter upon and vigorously prosecute to completion the proposed work, as soon as they are authorized to rely upon the national government for the coöperation that has been suggested.

The undersigned earnestly hope that this coöperation may be given.

They would respectfully represent that an important purpose for which the breakwater in Barnstable Bay is required is to furnish a sheltered roadstead for vessels entering and leaving the canal, and that this roadstead ought to be available as a harbor of refuge. There is need of such a harbor upon that part of the coast. With it vessels would not run the risks they now do in stormy weather to make Boston Harbor, and to avoid the fatal bight of Barnstable Bay. But a harbor of refuge to vessels in distress ought not to be the private property of a private corporation. It should belong to the nation, and only the common country should control and administer its beneficent advantages. That it may belong to the nation, the national government should build it.

It is further respectfully suggested that the great benefits it is shown will accrue to the commerce of the country from the construction of this new route of navigation, are of the same class as those to secure which appropriations are annually made by Congress for the improvement of the rivers and harbors of the country, and aid is furnished to railroads. This canal

would also be a step towards the entire canalization of the Atlantic coast, a measure that would conduce so much to economy in transportation, and to the safe prosecution of the coasting trade, both in time of peace and of war, that the promotion of such a measure might well be adopted as the settled policy of the United States.

More than all, the coöperation of the national government may be claimed on grounds of humanity.

Had the disasters that have attended the voyages around Cape Cod in the last thirty years been concentrated upon a single shoal or ledge of rocks, the appeal that would have gone up to a humane government from a thousand wrecks and hundreds of ocean graves, for buoys and light-houses and all the means of safer navigation would have been irresistible, and appropriations would have been made without stint. Yet, just the same validity and force, the undersigned do not hesitate to say, has the claim of the project of connecting Buzzard's and Barnstable bays by a navigable canal, upon the humanity of the national government.

For these reasons the undersigned respectfully commend the application of the Cape Cod Canal Company for an appropriation for a breakwater in Barnstable Bay, in connection with their works, to the favorable consideration of Congress.

JOSIAH QUINCY.

S. E. SEWALL.

D. E. WARE.

F. W. LINCOLN, JR.

J. N. MARSHALL.

REPORT OF PROFESSOR MITCHELL.

To the Board of Harbor Commissioners of Massachusetts.

GENTLEMEN,—In response to your letter to Professor Peirce, Superintendent United States Coast Survey, asking for a copy of that portion of my report which relates to physical surveys upon the Coast of Massachusetts, I send the following extracts which cover the portion of my work which was included in the project of the past season by request of your Board.

HENRY MITCHELL.

GREEN HARBOR RIVER.

This *river*, so called, is the drain of about fifteen hundred acres of marshes situated mostly in the township of Marshfield. It receives two considerable tributaries, and innumerable brooks and creeks in its meandering course. The lower reach of the river is known as Green Harbor, whose length from Turkey Point to the bar is about seven-eighths of a mile, and whose maximum low water width scarcely exceeds five hundred feet. A sand-bar obstructs the entrance, upon which there is from two to three feet of water at ordinary low tide. The average rise is nine feet, and vessels can take the ground within the harbor at low tide without injury. The shelter from winds and sea is good. As far as I could learn the trade of the place employs but one small vessel; but during the summer, many small yachts, for the accommodation of watering people, make here a rendezvous. It is not entitled to the slightest consideration as a port of refuge, although vessels have been known to run into it under desperate circumstances.

It has been proposed to reclaim the marshes by constructing a sluice-dam at the head of the harbor, and I visited the scene during

the month of June with the twofold object of determining the practicability of this reclamation, and the likelihood of resulting injury to the entrance. The problem of reclamation presented is one of the simplest kind, and I was enabled to reach a positive result from a few experiments and a very limited survey; but the question of injury to the entrance has perplexed me very much. I shall offer, however, an argument upon this point.

The place chosen for gauging the river was near Turkey Point, where the uplands approach the stream on either hand, and where a dam could be most economically and effectively constructed. The table which follows furnishes the elements for a profile of the section from upland to upland crossing the river at the place of gauging. (See Fig 4.)

The tide was observed for thirteen hours upon the 30th of June. The range was 8.90 feet, which is about what I should compute for Cape Cod Bay at the same age of the moon, and no unusual distortion of the profile could be detected. The marshes are nearly at the level of high water in this portion of the basin, and supposing, at the date of our observations, gates to have been closed upon the river at the time of low water, the accumulation behind them during the following six hours would have been, according to Professor Peirce's criterion, about three feet, so that the surface of the marsh would have been six feet above the water table at time of high water in the bay. This depth of three feet is largely in excess of the fresh-water supply, because many of the creeks do not fully discharge their tide waters during the fall in the main river. Our hydrometer at low water gave a density of 1.0195, indicating that the outflow was then three-quarters sea-water. Indeed the current observations show that the fresh-water discharge was exceedingly small, and that gates of ordinary dimensions may be relied upon for draining this basin perfectly.

The river at its embouchure flows into the sea in a course but little to the eastward of south, with rocks upon its left and sands upon its right bank. These sands driven by the waves, and the flood current, are constantly invading the river's mouth, but are driven back by the outflow, and the bar is for the most part formed of material from outside, which is left in the debatable district between the opposing forces. I think that it is only during heavy weather that the flood current, aided by the waves, can overbalance the scour of the ebb, even during dry seas, when the fresh-water outflow is itself too small to be considered, and I base my opinion upon the following considerations:—The shifting material is sand, and this is not suspended, but rolled or driven along upon the bottom at a rate

far less than that of the water itself, so that the progress that it ultimately makes, and the direction it takes, must be determined by the power and direction of the resultant of the forces, precisely as if these forces acted simultaneously. Now although the flood and ebb, at low river seasons are essentially the same as regards volume, they are quite unlike as regards velocity, *i.e.*, working power. The veins and arteries of the marshes are filled late and drained late as regards the tidal time at the mouth of the river, so that the greatest inflow is called for when the water is high upon the bar, while the greatest outflow is so much behindhand as to reach the bar when the latter has but a small section; the former therefore creates but little horizontal motion, while the latter creates a rapid current. When we consider that the work of a stream increases with the square of its velocity, we should not be surprised to find the ebb at the mouth of a river playing the dominant part in the excavation of channels. For instance, when the tide at our station had risen two feet or less than one-fifth of its range, the velocity of inflow was 0.50 feet per second, but when it had fallen to the same stage the outflow was 1.40 feet,—in other words the working power in the same section was *eight times as great upon the ebb as it was upon the flood*. If a sluice-dam were to be constructed, shutting out the tides from the marshes, the fresh-water outflow only would be left to resist the action of the waves, and as far as I can judge, the summer discharge would be impotent. In the introduction to this Report I have pointed out instances of little harbors that have been injured by weirs and dams, like that proposed for Green Harbor River, and I have little doubt that a decline in the depth on the bar will follow the reclamation of the marshes. It is true that the direction of the embouchure is favorable as regards shelter from the sea, and that the supply of material is not so great as at many points along shore, but I have about made up my mind that in course of time, after the dam is constructed, the inlet will become a "tide harbor," like Scusset and Sandwich, *i.e.*, dry at low tide, at least upon its bar.

Section of River at Turkey Point, (Fig. 4.)

Distance in feet.	Height above Low Water of June 30, in feet.	Remarks.	Distance in feet.	Height above Low Water of June 30, in feet.	Remarks.
0	13.46	Upland, left bank.	838.	9.17	On left bank of main stream.
36	12.29		856.	1.60	River bed.
59	10.00	Edge of upland.	858.	0 20	" "
131	9.61	Marsh, salt grass.	868.	—4.2	" "
196.8	9 33		878.	—5 8	" "
262.4	9.01	(Plane of high water=8.90.)	888.	—4.9	" "
318	8.63		898.	—6 0	" "
393.6	8.74		908.	—6.2	" "
459.2	8.99		918.	—6.3	" "
524.8	8.62		928.	—6.9	" "
557.6	8.99		938.	—6 2	" "
590.4	8.47	Left bank of stream.	948.	—6 1	" "
600	2.4	River bed.	958.	—5 4	" "
610	1.4	" "	968.	—5.0	" "
620	0.6	(Plane of low water=0 00.)	978.	—2.1	" "
630	—0.3	" " "	988.	—2.2	" "
640	—0.3	" " "	998.	—2.2	" "
650	—1.0	" " "	1,008.	—1.2	" "
660	—1.1	" " "	1,018.	—0 4	" "
670	—1.1	" " "	1,028.	0.2	" "
680	—1.1	" " "	1,038.	0.8	" "
690	—1.1	" " "	1,045.	1.6	" "
700	—1.2	" " "	1,088.	4.05	Right bank of main stream.
710	—1.2	" " "			Marsh.
720	+0.7	" " "	1,137.4	8.61	
730	8.59	Right bank of stream.	1,186 6	9 45	
772.6	8.88	On island.	1,207.2	10.40	
798.6	8.65	" "	1,269.	11.11	Turkey Point, bushes.
835.	9.34	" "			

Professor Peirce's criterion, to which I have referred upon a preceding page, is a useful generalization, and the first in this particular branch of engineering that has come to my knowledge. It is a rule for deciding upon the propriety of attempting to reclaim the marshes of a tidal river by the construction of a transverse sluice-dam. It was offered expressly for a guide in the cases before the Massachusetts Board of Harbor Commissioners, and finds its place properly in this Report, although somewhat technical.

PROFESSOR PEIRCE'S CRITERION.

"Draw a tangent to the tidal curve at the point where the tidal current changes from ebb to flood; if this tangent intersects the descending branch, the reclamation will preserve from overflow all the land which is higher than the point of intersection."

In explanation of the above, it is simply necessary to state that the river supply is regarded as uniform, and therefore to be represented upon the diagram as a straight line, which will, of course, be

the prolongation of that which represents the rise at the moment of *slack-water*, when the outflow and inflow are in equilibrio. If, as is usually the case at the mouth of a river, the observed curve is nearly that of the sines for a circle whose radius is half the range of the tide, reclamation is possible if the flood current begins to run up *within* 1 hour 43 minutes after the time of low water. If slack-water occurs at the instant of low-water stand, drainage of the marsh to a depth equal to the range of the tide is practicable; but if the flood current does not commence to run up until 1 hour 43 minutes after low water, the fresh-water accumulation, while the sluice-gates are closed, will equal the range of the tide. Fig. 2d of our plate illustrates these two cases.

This general rule is not applicable to the case where a bar, transverse to the river channel, below the observer, obstructs the propagation of the complete tide wave. In the case where a "submersible" dam exists, the rising curve within the obstruction resembles that observed outside, except that the lower portion, to the height of the dam, is cut off. If, for instance, the dam is elevated to the height of half tide, no tangent to the tidal curve within, will intersect the descending branch, and yet the case may be one of possible drainage to an adequate depth. In Fig. 3 I offer curves plotted from simultaneous observations near Hyannis, Massachusetts, in which the larger tide is that of the harbor, and the smaller that of Dunbar's Salt Pond, which is separated from the harbor by a natural bar, considerably elevated above the plane of low water outside, although never dry. No fresh-water feeders exist, and drainage to the level of the bar is of course possible, although the criterion (misapplied to the case) would say not.

NORTH RIVER.

Dean's History of Scituate published in 1831, furnishes a brief description of the North River which I shall quote, not only because as a general sketch it is still sufficient, but also because it comments upon the facilities for ship building and navigation which the river afforded before the recent disastrous inroads of the sea.

"This stream received its name before 1633, and probably from the circumstance that its general course is from south to north, or that it was farther north from Plymouth than South River in Marshfield, which meets the North River at its mouth. The North River is a very winding stream, flowing through extensive marshes, sometimes as it were, sporting in the broad meadows in the most fanciful meanders, and sometimes shooting away to the highlands which border the meadows. There is one reach which has long been called the 'No Gains' from the circumstance that, after flowing from

side to side, and almost turning backwards for several times, it has in fact flowed several miles, and gained but a few rods in its direct progress to the sea. From the sea to the North River bridge on the Plymouth road, an air-line would not exceed seven miles; while the line of the river amounts to eighteen miles. The tide rises at the North River Bridge from three to five feet, and there is a perceptible tide two miles higher up. It has three chief sources, the Namatakeese and Indian Head, which flows from the Matakeeset Ponds in Pembroke, and the Drinkwater, which has its sources chiefly in Abington. The tributaries are the three Herring brooks on the Scituate side, and the Two Mile brook and the Rogers' brook on the Marshfield side."

* * * "Just below and at an air-line distance of a little more than three miles from North River Bridge, is Union Bridge. A half mile lower on the Scituate side is King's landing. And about half a mile on the same side, is Hobart's landing. Here we believe the first vessels were built, by Samuel House, as early as 1650." * * * "Here the ship Columbia (Capt Kendrick) was built by James Briggs, A. D. 1773. It was the first ship that visited the northwest coast from this country. Capt Kendrick explored the river Oregon, and named it from the name of his ship, which name will probably prevail henceforth. At the distance of another half mile below, is Little's Bridge, at which point we believe vessels have been built on the Marshfield side. The meadows above this station are of very various width, in few places exceeding a mile; but below there is a wide expanse of marsh, anciently called the 'New Harbor marshes.' The scenery here is on a sublime scale when viewed from Coleman's hills, or from the Fourth Cliff. The broad marshes are surrounded by a distant theatre of hills, and the river expands and embraces many islands in its bosom. Here it approaches the sea, as if to burst through the beach, but turns almost at right angles to the east, and runs parallel with the seashore for nearly three miles before it finds its outlet, leaving a beach next the sea for nearly twenty rods in width, composed principally of round and polished pebbles, excepting only the Fourth Cliff, a half mile in length, which comprises many acres of excellent arable land. Nearly a mile above the river's mouth is White's Ferry, where is a wharf and a small village on the Marshfield side. Here vessels have been built, and many that have been built above here receive their rigging. The river's width may be estimated as follows: In ordinary tides, at Union Bridge, seven rods; at Little's Bridge, nine rods; it expands below to a half a mile in width, where it is now called Fourth Cliff Bay and formerly New Harbor; here the channel divides, and unites again a mile below; a half a mile above its mouth it is fourteen rods in width. The channel at its mouth often shifts its place owing to the nature of the sandy bottom, and to the violence of the stream and the tides. It seldom affords more than nine feet of water, even when there is but one channel; but it often happens that there are two channels, when the water is something less. This fact accounts for the difficulty and expense of carrying out the vessels built upon this river; and yet only in part, for there are shoals above, over which vessels of 200 tons and upwards must be lifted with gondolas or heaved with kedges. The principal are Wills' Shoal at the upper part of the New Harbor Marshes, and the Horseshoe Shoal."

Since the above statement was written, 40 years have elapsed, during which, important physical changes have occurred, which, in connection with other circumstances, have led to the total abandonment of all commercial enterprises upon the North River; and the project now entertained for reclaiming the marshes by sluicing out the tide, involves the sacrifice of no interests of navigation.

The injuries which the channel-way has suffered have been principally due to the waves, which, during violent storms, have burst through the narrow strip of beach that separates the lower reach of the river from the ocean. Appreciating the importance of this natural dike in connection with the projected reclamation, I devoted some time to its inspection with a view to pointing out its weak places. With the exception of Fourth Cliff, which appears to be the smaller portion of a high hill, once extending into the sea, the entire beach is but a windrow of sand and stones cast up by the waves and subsequently modified in part by the winds, differing only in matters of detail from the *littoral cordon* of our Southern States.*

Shingle Levees.—A portion of this beach is permanent, the forces which created it, having, as it would seem, ultimated their effects. I refer here to the shingle levee, which from the point where the stream "*approaches the sea as if to break through,*" extends like a strong bulwark half way to the river's mouth, interrupted only by Fourth Cliff from whose waste a portion of the material of the levee seems to have been selected.

It is not impossible that the river once found its outlet between the Third and Fourth Cliffs, as most of the people living in the neighborhood conceive. Instances are numerous where streams have been turned aside, and sometimes cut off from the sea, by the advance of shingle. Indeed the whole phenomenon may be said to belong especially to the present time, geologically speaking, and many of the most striking exhibitions of it fall within the historic period. For instance, the Romans found at Dover, an estuary without any obstruction from shingle; many years after, however, there advanced along the coast a ridge of this material, and eventually the old port was ruined, the efforts to save it having been commenced too late. Nearer home than this we are witness in our own times of the steady advance of a shingle levee (Brewster Bar)

* Of our Atlantic sea board from Quoddy Roads to Key Biscayne, one-sixth part is rock-bound, one-tenth composed of drift antecedent to the present geological epoch, and the remainder sands winnowed out by the waves. Beaumont estimates that "one-third of the sea borders of the world is defined by the littoral cordon," *i.e.*, is shaped in outline by sands cast up or strewn along by the sea.

in Boston Harbor which threatens to cross the main channel. Fortunately Congress has listened to the prayers of the Harbor Commissioners, and has provided for arresting its progress.

Shingle levees appear to me to be worthy of careful study, because they are the best natural measures of the power of storm waves, and I have made the dimensions of this one at Scituate a special subject, in order to ascertain to what height the *dikes*, required further down the beach, must be carried in order to prevent the overflows that now frequently occur.

The portion of the shingle levee which lies between Third and Fourth Cliffs is about four thousand three hundred feet in length, with a general elevation of sixteen feet above the plane of high-water, and a base of two hundred feet. It is composed of round and oval stones, those near the water line of the seaward side being the largest, and those upon the summit the most flattened. Paving stones are gathered from the lower portions of the outside, but upon the summit the average size may be stated at three and a half inches maximum diameter, and one inch thick in the middle.

The crest of the levee appears to the eye perfectly horizontal, and but slightly curved back from a straight line. The table of levelings given below, however, shows that there are depressions at either extremity, and that it is only the highest portion that is very near the horizontal for any considerable distance.

Longitudinal Section of Shingle Levee.

Datum=High Water of the Sea.

Distance in metres.	Height above mean H. W. of Sea.	Distance in metres.	Height above mean H. W. of Sea.	Distance in metres.	Height above mean H. W. of Sea.
0	14.32*	5.40	16.15	10.20	13.71
60	12.83	6.00	16.15	10.80	13.04
1.20	15.45	6.60	15.65	11.40	13.41
1.80	17.00	7.20	15.30	12.00	12.71
2.40	16.40	7.80	14.73	12.60	11.01
3.00	16.70	8.40	15.03	13.20	9.21†
3.60	16.77	9.00	14.29	13.20	13.21‡
4.20	17.10	9.60	13.71	13.40	22.41§
4.80	15.95				

* Foot of Fourth Cliff.

† On Levee.

‡ On Bluff.

§ On Third Cliff.

Within the memory of persons now living in Scituate, the sea has once (during the Minot's gale) leaped over the depressed portions of this levee near its extremities, and the sea water has several times

been seen oozing through in these places, but to no extent that could be injurious.

The height of this levee is greater than is usual among such formations, and its stones are larger. The maximum height given in our table is 17 feet above mean high water of the sea. Redman estimates the ordinary height of these formations in Great Britain at 6 to 10 feet.

The two slopes of our levee are very unlike in some respects; that toward the sea presents a series of berms,—miniatures of the great levee, thrown up by subsequent storms,*—while the leeward slope (toward the river) is a smooth hollow curve. (Figs: 56 and 57.) These are precisely the features we should expect to find in a structure which has resisted the storms of centuries. The fore slope should present the greatest resistance to the onset of the waves, and the rear slope the least resistance to the escape of overflowing water. I am reminded here of a short section of shore defence that I observed on the outer beach of the "*Pointe de Grave*" in the Bay of Biscay, which was constructed in the form of a *stairway*. The engineers informed me that it had resisted the sea better than anything yet devised. The waves of ordinary storms do not seem to weaken, but rather to strengthen the shingle levee. They cast up the windrows or berms, of which I have spoken, and thus prepare it to withstand more effectively the onset during violent gales.

In the following tables I give the elements for profiles of ten cross sections of our shingle levee, and a mean section from the higher and less disturbed portion.

* Redman and Coode in their papers read before the Inst. C. E. used the word "fulls" for these windrows or berms which mark the action of the recent storms.

Sections of Shingle Levee.

	SECTION I.		SECTION II.		SECTION III.	
	120 Metres.		240 Metres.		360 Metres.	
	in Distance feet.	Height above mean H. W. of sea, in feet.	in Distance feet.	Height above mean H. W. of sea, in feet.	in Distance feet.	Height above mean H. W. of sea, in feet.
Fore Shore.	65.6	0.13	-	-	78.7	0.21
	59.0	2.33	-	-	62.3	4.51
	52.5	4.63	-	-	52.5	6.41
	45.9	4.93	65.6	1.60	45.9	7.31
	39.4	6.03	52.5	5.20	39.4	9.11
	32.8	6.43	36.0	7.80	29.5	10 17
	19.7	9.05	29.5	9.50	22.9	13 27
	9.8	13.45	19.7	8.83	16.4	15.17
	6.6	14.15	6.6	13.80	6.6	15.57
	0	15.45	0	16.40	0	16.77
Crest.	6.6	14.95	13.1	14.20	3.3	16.47
	19.7	12 85	26.2	9.60	16.4	13.87
	32.8	9.82	39.4	6.12	26.2	10 04
	45.9	7.72	65.6	2.80	36.0	6.70
	65.6	6.42	82.0	1.40	59.0	3 90
	98.4	4.52	98.4	0.70	68.9	4 00
	131.2	2.72	111.5	-1.30	85.3	3.00
	144.3	1.92	-	-	104.9	2.30
	154.2	1.12	-	-	118.0	-0.10
Back Shore.	164.0	-1.28	-	-	134.5	-1.42

NOTE.—The datum plane is mean High Water of the sea. The distances in metres are measured along the crest from Fourth Cliff.

Sections of Shingle Levee.

	SECTION IV.		SECTION V.		SECTION VI.	
	480 Metres.		600 Metres.		720 Metres.	
	Distance in feet.	Height above mean H. W. of sea, in feet.	Distance in feet.	Height above mean H. W. of sea, in feet.	Distance in feet.	Height above mean H. W. of sea, in feet.
Fore Shore.	88.6	—1.56	—	—	—	—
	72.2	1.14	98.4	—2.50	—	—
	62.3	3.14	75.4	0.20	88.6	—2.80
	55.8	4.84	65.6	2.50	55.8	2.90
	39.4	7.04	55.8	5.10	49.2	4.50
	32.8	8.74	49.2	5.10	32.8	7.30
	29.5	9.82	36.0	7.40	22.9	8.00
	22.9	12.45	29.5	7.90	19.7	9.07
	13.1	12.85	19.7	9.38	9.8	10.90
	6.6	13.95	9.8	11.90	6.6	12.00
Crest.	0	15.95	0	16.15	0	15.30
Back Shore.	9.8	14.65	9.8	15.65	9.8	14.30
	19.7	12.55	16.4	14.55	26.2	10.60
	42.6	6.63	26.2	11.55	42.6	6.40
	75.4	3.86	32.8	9.12	75.4	2.40
	108.2	2.76	49.2	4.86	108.2	1.50
	141.0	—0.24	65.6	2.66	141.0	0.70
	157.4	—0.74	82.0	1.76	173.8	0.70
	164.0	—0.04	114.8	1.26	—	—
	183.7	—0.14	147.6	0.56	—	—

Sections of Shingle Levee.

	SECTION VII.		SECTION VIII.		SECTION IX.		SECTION X.	
	840 Metres.		960 Metres.		1,080 Metres.		1,200 Metres.	
	Distance in feet.	Height above mean H. W. of sea, in feet.	Distance in feet.	Height above mean H. W. of sea, in feet.	Distance in feet.	Height above mean H. W. of sea, in feet.	Distance in feet.	Height above mean H. W. of sea, in feet.
Crest.	-	-	-	-	-	-	114.8	-5.00
	-	-	-	-	-	-	88.6	-2.00
	98.4	-3.00	-	-	124.6	-4.56	65.6	1.20
	82.0	-1.10	-	-	108.2	-3.66	59.0	2.90
	65.6	2.40	12.14	-4.50	75.4	-0.16	55.8	4.10
	59.0	4.83	88.6	-1.20	68.9	1.24	49.2	4.40
	49.2	5.00	68.9	1.20	55.8	4.72	42.6	5.40
	42.6	6.70	55.8	4.50	39.4	6.14	39.4	6.70
	32.8	6.91	42.6	6.40	22.9	7.14	26.2	7.01
	22.9	8.80	29.5	6.64	13.1	10.34	16.4	8.50
	9.8	11.60	6.6	12.20	9.8	10.94	6.6	10.70
	0	15.03	0	13.71	0	13.04	0	12.71
	6.6	13.70	9.8	13.30	6.6	12.80	6.6	12.30
	16.4	11.10	29.5	9.60	16.4	11.40	16.4	11.20
	32.8	8.11	42.6	7.50	29.5	9.11	49.2	7.40
	49.2	5.00	75.4	4.87	55.8	5.74	82.0	2.88
	72.1	2.30	108.2	2.90	72.2	3.94	114.8	1.20
	98.4	1.70	141.0	1.00	104.9	2.04	147.6	0.50
	127.9	0.60	173.8	0.70	121.4	1.64	180.4	-0.70
	164.0	0.60	-	-	154.2	1.34	-	-
	-	-	-	-	186.9	0.44	-	-

Caland constructed the great dike of West Capelle under the conviction that the action transmitted by the shock of the waves should vary with the square of the height of the water covering the talus, and that the base of the fore slope of a dike should be in proportion to the square of the height.* If I take the dike of West Capelle as the standard, I obtain for the Scituate levee the slope of 4:1. Our levellings give 3:1 near the crest, and 5:1 as an average for total slope. As far as my observations have gone—and this is not so far as to admit of my speaking with entire confidence—the fore slopes of shingle levees are constant, *i.e.*, the base varies with the first power of the height. Near the crest the slope is greatest, usually 3:1 where undisturbed, but the total slope is 5:1. When I visited the grand dike of Petten in 1868 I found Mr. Conrad *pitching* the storm belt with basalt blocks at 3:1 and 5:1. From his history of this great work,† I find that these slopes for stone-pitching are always adopted irrespective of the total height.

The leeward slope for different sections is very nearly the same from point to point except near the base, where it is affected by different elevations of the river bed upon which it lies. It is probably the curve of least resistance for the material employed. It sometimes approximates quite closely the cycloid, and it always has an aproning to protect the base. If it were steeper, the fall of overflowing water would excavate the marsh at the foot and endanger the whole structure; if it were less inclined, there would not only be a waste of material, but in the event of a rapid succession of overleaping seas, the accumulated waters might react and burst through the crest. Dikes and breakwaters are usually built with very steep rear slopes, and the larger part of the disasters which have befallen these structures, has resulted, not from the force of the sea upon the fore slope, but from the fall of overleaping seas upon the inside works. The shingle levee may fulfil many purposes in nature besides that of defence, but viewed simply as a bulwark it discovers a wonderful economy.

Below Fourth Cliff the shingle levee continues for a considerable distance, but gradually loses its distinctive character and merges with the sands, which seem to have preceded all other material in the march southward. In the year the communities about the North River attempted to cut a new outlet in this portion of the beach, using at first hand labor, but ultimately employing a dredging

* *Essai sur les Travaux de Fascinages par U. N. Kümmer.*

† Verhandelng over de Hondsbossche Zeeweerling door J. F. W. Conrad Ingenieur de 1ste klasse van's Rijks Waterstaat.

machine. The bottom was removed to a depth of 6 feet below the marsh level, but not to the low water of the sea. Contrary to expectation, the water, instead of flowing seaward, rushed in towards the river—Fourth Cliff Bay being, as we find from our observations, below the high water level of the sea. The influx was at times very strong, but seemed quite powerless to enlarge or deepen the trench through the firm and unctuous soil of the marsh—to use the expression of the workmen, “*the stream wouldn’t gull.*” Heavy weather came on soon after the work of the dredging machine ceased, and the waves drove in masses of sand and stones, which soon choked up the pass. In course of time a shingle levee formed across the inlet, and rose to the height of 10 feet above the high-water plane of the sea. I give a section of this new formation, in which no decided berms appear.

Cross Section of New Levee.

	Distance from Crest, in feet.	Elevation above mean H. W. of sea, in feet.		Distance from Crest, in feet.	Elevation above mean H. W. of sea, in feet.
Fore Slope.	137	—7.6	Rear Slope.	0	10.9†
	102	—4.6*		20	7.3
	72	—1.8		33	5.3
	49	1.5		59	3.5
	39	4.0		125	1.8
	33	5.2		192	—0.3
	23	6.9		256	—1.7‡
	13	10.5		—	—
	6	10.7		—	—

NOTE.—The average fore slope, above the plane of high water, is 5 : 1; while the greatest inclination, (near the crest,) is 2½ : 1.

* Half tide or mean level of sea.

† Crest.

‡ H. W. plane of river.

I glean one very curious fact from those employed in opening this channel, viz., the original bank of shingle was found to extend downwards only to the surface of the marsh which was not sensibly depressed beneath its weight. I infer that, as Fourth Cliff wears away the whole beach falls back, and the present banks of sand and shingle are really superimposed upon ancient meadow lands or river channels. The marshes are not floating bogs like the *koogs* of Denmark, or liable to slump down after enclosure, like the *polders* of Holland. The newly formed levee, across the mouth of the artificial outlet, exerts a pressure of over 1,200 lbs. to the square foot upon the marsh beneath its crest, and the weight of the original bank, as far as I can

judge, was over 1,700 lbs. to the square foot under the crest. I have allowed in these estimates 25 per cent. for voids. Old rubble breakwaters, that have been shaken down by the waves to a state of repose, occupy still a space 25 to 30 per cent. greater than the rock *in situ*.

Some shrinkage will no doubt take place after drainage is effected, but this will not, I think, exceed 10 to 12 per cent. If the *water-table* is dropped four feet, I shall expect the marsh surface to sink about six inches.

Shingle Levees Elsewhere.—My assistant, Mr. H. L. Marindin, has recently examined the levee near Chelsea, Massachusetts, the southern portion of which is more exposed to the sea, and therefore the highest, reaching an extreme elevation of 14.13 feet above mean high water. The fore slope of this portion has an average inclination of 5:1, and an extreme, near the crest, of $2\frac{3}{4}$:1. The exposure is only to the south-easterly quadrant, and the shallow flats which extend a long way to the seaward break the force of the sea. The longitudinal profile of this levee shows a decline of height as the observer moves to the northward, reducing the angle of exposure, and falling under the shelter of Nahant. This levee is without distinct berms, and its rear slope is 3:1 above the apron.

The highest shingle levee in the world is Chesil Bank, on the south coast of England, in a situation peculiarly exposed to the violent seas that rush into the Channel. Its height varies from 23 to 43 feet along a distance of 10 miles. The inclination of the fore-slope in the most perfect part of this levee is 5:1.

Upon the borders of the Bay of Audierne, in Brittany, there is a shingle levee nearly eight miles in length, whose average height is 16 feet,—the same as our levee at Scituate, and like the latter, its seaward face is a series of berms.* The fore slope is 3:1. "The shingle levee," says Beaumont, "when viewed as an isolated phenomenon, merits but little attention, but in its relations to other phenomena we recognize that it has a great influence upon a crowd of important facts."

Perhaps the most singular freak of the sea in the way of dike building is to be found upon Salt Key, one of the smallest of the Bahama Islands. Here occurs a nearly perpendicular wall, about 12 feet high, constructed wholly of *conch shells*, nearly all of them per-

* A sketch of this levee is given in Beaumont's "*Geologie Pratique*," page 225. In another part of the same book mention is made of the three Druidical *men-hir* upon the little island of Quemenès, off the coast of Brittany, followed by a statement that this island is less than 33 feet above the ocean, and that if it had ever been traversed by the sea during the past 2,000 years the *men-hir* would have been upset by the washing away of the soil in which they stand.

feet. One might suppose from the uniform height of this wall, and its perfect alignment, that it was a work of art—except that to build a “dry wall” of conch shells would rather puzzle human ingenuity.*

The dikes along the coasts of Europe may be said to furnish limiting measures of the heights of overflows not wholly local in their significance. Until a comparatively late period the sea dikes in Holstein and Schleswig were raised but 10 feet, and in Holland but 10 to 13 feet above ordinary high-water mark. Modern engineers, however, have carried these works to greater elevations. On the Schleswig coast $18\frac{1}{2}$ feet above the highest spring tides is regarded as entirely safe.† On the Dutch Coast, after a recorded experience of four hundred years, the grand dike of Petten has been carried up to 21 feet above ordinary high water,‡ and upon the Mediterranean shore of France $16\frac{1}{2}$ feet is proposed for new works.§ As the injury suffered by sea dikes has been principally due to the rush of water down the landward slopes during overflows, it has been deemed prudent to raise the crests of the most exposed and important works to the extraordinary heights I have stated.||

Breakwaters do not furnish what I have termed “limiting measures,” because many of them have been built with the expectation that storm seas would leap over them, while others have been carried high for the sake of *weight*. Although most of the breakwaters have been built in situations already partially sheltered, there are instances where they have been more exposed than the adjacent coasts.

Sand Beach.—Further down the Scituate beach the stones gradually give place to sand, and the shore no longer reflects the action of the sea alone, but is diversified by dunes blown up by the winds. There are occasional points where traces of overflow appear, and I give the section of one of the slue-ways formed by the Minot’s gale, and traversed by the sea at least once a year since that memorable storm:—

* Reported by myself in 1867.

† Testimony of Capt. Carstensen, Dike Inspector, cited by J. Paton, M. Inst. C. E.

‡ From a diagram entitled “*Scituate der Pettimer Zeewering*,” furnished me by J. F. W. Conrad, engineer of the *Waterstaat*.

§ *Ponts et Chaussées, Département de l’Herault*, report of the Engineer in Chief.

|| The highest dike that I call to mind is that of West Capelle, over 26 feet above the tide.

Section from Upland to Ocean, crossing North River at Slant Spar (Fig. 10).

Distance in feet.	Elevation in feet.	Distance in feet.	Elevation in feet.
0	4.34	478.	—3.6
36.	1.72	493.	—2.9
85.	0.93	508.	—2.9
125	1.44	523.	—2.9
141.	1.19	538.	—2.9
243.	0.37	554.	—0.92
262.	0.72	590.	1.08
328.	—0.92	656.	2.89
343	—2.9	934.	5.05
358.	—3 0	1,000.	5.50
373.	—4 5	1,066.	6.78
388.	—4.9	1,197.	8.76*
403.	—4.2	1,262.	6.68
418.	—4.2	1,331.	4.94
433.	—4.2	1,387.	0.95
448.	—3.9	1,426.	0.71
463.	—3.9	1,505.	—4.00

NOTE.—Datum=High water plane of river, June 23, 1870=1.70 feet below mean high water of sea.

*=7.06 above mean high water of sea.

The maximum height of this slue-way is seven feet; this may be regarded as the measure for annual overflow.

Professor Whiting, in his excellent paper on Provincetown Harbor, published in the Coast Survey report of 1867, says (speaking of the outside coast), "Already the breakers have dashed over the narrow strip of sand-beach at what I term the oblique section," which has an elevation of fourteen feet above high water of the ocean. The exposure at Fourth Cliff is about the same in north-east gales as that of the outside shore of Cape Cod.

I have given in Fig. 10 a profile plotted from the preceding table, because it illustrates so well the double action in overflow—the violent dash against the seaward face, and the flowing down on the opposite slope. On sandy shores a mound thrown up by the sea can nearly always be distinguished from one due to the wind; in the former the steeper slope is *seaward*, in the latter *leeward*, so that an overflow reverses the order of the slopes found in a dune.

In running water (in the bed of a river for instance) the sands take the form of flat dunes, which correspond in the order of their slopes with those on land.

With no desire to involve myself in the discussion of wave

theories, I must state one point because of its bearing upon my general subject. The positive and negative, or *crown* and *hollow* portions of a storm-wave are of unequal heights, so that the rise above the sea-level (plane of equal volumes) is considerably greater than the fall below. Many shoals, whose depths given upon our charts are less than half the range of ordinary storm-waves, have never been seen exposed in the trough of the sea. Some years since a heavily-laden ship, drawing about eighteen feet of water, was driven by an easterly gale across several of the Nantucket shoals, upon which, according to our maps, the depths scarcely exceed eleven feet. She struck heavily many times, but the leadsmen never called less water than the chart indicated. Standing upon the beach during a heavy storm, one rarely sees, as the waves retire, much more of the strand than in ordinary weather; and Robinson Crusoe's thrilling account of his race for life across the floor of the ocean, during the recoil of the sea, disturbs our confidence in him at the outset of his narrative.

General rise.—The *mean-level* rises during storms from seaward, and this must always be taken into account in projects for dikes and dams. This *general rise* can best be measured by observing the height of the water's surface in sheltered coves and harbors.

Major Graham's report on Cape Cod Harbor shows, from tidal observations between 1833 and 1835, that a twenty-four hours' gale from the south-east (*i. e.* directly into Massachusetts Bay) causes a general rise of 3.33 feet. The coping of the United States dry dock at Charlestown was designed to be above the highest tide, and was placed 4.69 feet above mean high water. The sea has actually risen 0.4 above the top of this coping once during the past twenty years. If we grant that the storm-rise is affected by the configuration of a harbor or bay in no greater degree than the ordinary tide, we must apply a correction to the Dry-Dock rise of nearly ten per cent. in order to reduce it to its proper proportion for the outside coast. We have then four and a half feet for the *general rise* during violent storms. I do not think it necessary to go back more than twenty years in estimating the height to which the sea is likely to rise, because there is no economy in providing for contingencies which do not present themselves more than once in a lifetime. In Holland, where the lives of thousands depend upon the security of the dikes, the works are only provided for ten feet general rise, although the tradition of the Cimbrian flood is over forty,—and the Deluge greater yet.

Dean's history mentions that the sea has been known to flow over the isthmus which divides Scituate Harbor from the North

River, and I am informed that during the Minot's gale the rush over this place was so great as to sweep away fences, &c. I had not time to run a line of levels over this isthmus, which I regret, because I think it would have given an excellent measure for "*general rise*." The overflow in the Minot's gale, to which I have just referred, injured the lands to such an extent, that it was not until the third season after, that the English grass recovered its former luxuriance.

To recapitulate: the heights to which the sea has run upon the outside shore above mean high water of the sea are,—

In the long past,	17 feet.
In the heaviest gale observed,	13 "
In winter storms,	7 "

The beach should be protected against a fourteen feet run of the sea. We have found between the Fourth Cliff and the South River junction only five slues which fall below this standard height, and these we have sectioned. The point of the beach near the mouth of the North River is generally low for 1,200 feet, but will afford, I think, no source of trouble for many years.

The interior dams must be at least three and a half feet, but need not (if perfectly sheltered) exceed four and a half feet above the mean high water plane of the sea, to escape overflow from the "*general rise*" during storms.

The bench of our survey is situated on the right bank of the river, nearly opposite Slanting Spar. It is within a circle cut upon the highest point of a boulder, which boulder may be distinguished from other rocks by its having an iron ring-bolt on one side. This bench is 1.23 feet above *mean high water of the sea* (as computed).

Mouth of River.—During the last century the river mouth has been forced to the southward by the advance of the beach a distance of nearly one mile, and since our survey of 1858, about 1,000 feet. A beach of small shingle now stretches from the coast south of the embouchure, and overlaps the beach of which I have been speaking, so that the river makes a sharp turn just before issuing upon the sea.

Between the mouth of the river and White's Ferry the stream has been injured by overflows from the sea, which have not only rendered the channel more shallow but made it narrower than formerly, the material of the beach being much of it too heavy for the ebb-current to remove, and the opposite bank of the stream too firm to yield in due proportion.

The shoalest place in the river is in the vicinity of the slue-way of which we have given the section in Fig. 10. It is encumbered with banks, and the average depth of a pathway 100 feet wide, along the line of greatest depression, is only five feet at ordinary high water. Tradition says that nearly a century ago the mouth of the river was at this point, and that since the river moved on there have remained here impediments to navigation. However this may be, the Minot's gale re-opened a track over the beach, and poured into the stream a mass of gravel and shingle that completed the ruin of the river as far as navigation is concerned. We have made a close survey of this portion of the stream, and deposited a chart of it at the office, bearing the names of the observers.

Character of the Marshes.—Relative to the constitution of the soil I shall venture to say very little, because the subject is beyond my ken, but this little will be said with the hope of eliciting further information of a better description.

The surfaces of these marshes are nearly horizontal and lie at the level of high tides. To my mind they are not to be accounted for under the term "glacial paste" or "river debris." I do not regard them as detritus from the interior, but, in the main, as products of the waste of the coast. I have found them in sheltered coves or angles of the shore in high countries, in low countries and in islands far from the continent, wherever the coast yields to the dash of the sea.

When a headland crumbles down in the attack of the waves the materials are assorted almost immediately: the coarse sand, gravel and stones are strewn along to form the littoral cordon, but the finer materials are held in suspension till chance gives them the opportunity to settle in sheltered places, perhaps under the lee of the cordon itself. Even upon coasts where the shores are already composed of sands as in North Carolina, the work still goes on; the sands are ground up by the waves, and borne into the lagoon by the current. I have observed at Hatteras Inlet that after severe gales the sea along the coast becomes milky with fine quartz sand which the currents at the inlets bear into the sounds and there relinquish to form banks which in course of time are covered with sea-grass. The coast line falls back steadily and the lagoons fill up preceptibly. The Hatteras beach has probably been thrown up by the sea along the *breaker line* of a bank (the submerged prolongation of the continent which here has but a slight inclination towards the ocean) and as the coast falls back the cordon is still supplied with coarse material from the underlying ground, while the waves find, ready made, much fine material with which to fill up the lagoons. I have

selected Hatteras for my illustration because it is an extreme case. The sluggish rivers do not render turbid this portion of Pamlico Sound, and the ebb current at Hatteras Inlet is usually very clear. I do not of course mean to say that the outside coast alone supplies shoal building material for all parts of this interior sea, because I have often seen the waters flowing from Croatan very much laden with sediments.

When my friend Whiting shall have executed his promised map of the "completed contours" of the half destroyed headlands of the New England coast, you will perhaps discover adequate sources of supply for many shingle levees, travelling beaches and fertile marshes, without drawing upon your imagination for visions of other lands that have long ago sunk into the sea and left no sign.

The fertile polders of Holland which are supposed to have been formed directly or indirectly from the deposits of the Rhine, are underlaid with peat, but the new and more fertile marshes of the Humber which can have no similar origin are without peat, and are seventy-six per cent. *fine sand* "with only four per cent. organic matter."* Professor Phillips in his geology of the Yorkshire coast says: "The materials which fall from the wasting cliffs between Bridlington and Kilnsea, are sorted by the tide, according to their weight and magnitude; the pebbles are strewed upon the shore, beneath the precipice from which they fall; the sand is driven along and accumulated in little bays and recesses; whilst the lighter particles of clay are transported away to the south, making muddy water, and finally enter the great estuary of the Humber, and enrich the level lands under the denomination of warp." The term "warp" used in the above quotation refers to the practice of building submersible dams for the sake of catching sediments and forming thus new lands—the process is called "warping" and is employed also in the Netherlands.

I think that the popular notion that the deep sea is being generally filled up with material torn from the continent is erroneous. The facts seem rather to indicate that it is the sheltered indentures of the coast that are receiving deposits.† There are indeed evi-

* "On reclaiming land from seas and estuaries, by James Oldman, M. Inst. C. E."

† Not to speak too critically, the form of a profile of soundings extending from the continent is this: A long slope from the shore line to the 100 fathom curve, then a rather sudden pitching down to the floor of the ocean. The distance to which the long slope extends from the coast varies in different profiles, but the *depth* at which the sudden pitching off commences, seems to be the same not only in many profiles from our own shores, but from the opposite shores of the Atlantic. Perhaps this long slope measures the depth of
itation due to meteorological causes.

dences that the ocean proper is, in many localities, pushing its way into the continent. It is particularly noticeable that gulfs and bays which open in the direction from which heavy gales are prone to blow, are extending without any diminution of average depth along their axial lines, except where rocks resist for a while the wear of the sea. As an example, and a good one, because resting upon positive knowledge, I offer the case of the Gulf of Gascony in the neighborhood of St. Jean de Luz, where repeated surveys show that the submerged contours are falling back and the bay actually extending and deepening. The material scoured away is ground up fine by the waves, cast upon the beach, and finally blown away in dunes towards the interior.* The bight of Cape Cod Bay below the Plymouth entrance bears every trace of an encroaching sea. The water is bold close in shore, so that a man-of-war may ride at anchor within what was probably the base of the high hill whose remaining portion bears the name of Peaked Bluff. The waves have carried none of the material seaward (of this we are sure from the character of the bottom), but have swept it along shore to the eastward, the fine sands to be formed into dunes, and the shingle to be moved on and accumulated until it shall become equal to the protection of the shore by resisting the onset of the sea.

I have not, in our repeated surveys, seen the slightest evidence that the material of the falling bluffs of Boston Bay are borne out to sea. I think the harbors and coves have received it all.† The ebb tidal currents seem to have kept the channels sufficiently free and may have carried out to sea some very light substances, but we do not find them deposited there.

I am inclined to think, with Admiral Davis, that the waves "eject or repel" the debris of the continent which falls within their domain, that there is no permanent deposit or rest for such materials till shelter is reached; I differ however from this writer in respect to the carrying powers of the flood current.‡

Mr. A. Savary, an engineer residing at East Wareham, has written me an able and very interesting communication concerning Buzzard's Bay, in which he gives me the results of observations—some of them stated numerically, which show that the sheltered basins at the upper end of the bay are filling up with sand and stones torn from headlands (below) which are wasting under the

* From a lithograph copy of a report furnished to me by the author, Bouquet de la Grye, Hydrographic Engineer of the W. Coast of France.

† I must again refer you to the letter of Professor Agassiz, quoted in the introduction to this Report

‡ See memoir of Lieutenant Chas. H. Davis, Fourth Vol. (new series) Am. Acad. Arts and Sciences, also Smithsonian Contributions of 1851.

action of the waves during southerly gales. Some of these basins, he says, are used for planting oysters, and from his own experience states that after a gale the oysters are always found higher up the stream. He however attributes this movement altogether to the flood current* and makes it dependent upon the depth of superincumbent water—a conclusion that seems to be opposed to well established laws of hydrodynamics, although I am aware that some English engineers of eminence (among them Mr. Calver) still insist upon making *weight* an element in the friction of running water.

The views I have entertained relative to the restoration to the continent of all the material washed from its bluffs and headlands by the sea, must be modified when we come to consider islands. Where these are crumbling down under the action of the waves, we usually see a loss upon the windward shore, and a reappearance of the material upon the leeward side. Sometimes we find two hooks extending leeward from either end of a wasting island, as in the case of Nantucket, and these hooks, in other cases, unite under the lee and enclose lagoons, which ultimately become, perhaps, marshes. High islands may thus gradually be converted in low atolls (if I may use this term), which occupy more than their original share of the ocean bed. There are, however, many cases where the wasted material does not reappear, most prominent among which, is the familiar instance of Helgoland, a lofty island which in the eighth century was a thousand times its present area.

To return to the North River Marshes, I must confess that there is one feature in them which is more characteristic, I think, of river deposits than of mere tide lands. I refer to the natural levee along the river's brim, which is, perhaps, one foot more elevated than the marsh further back. In many places this slight elevation enables a heavy growth of clover to exclude the meadow grasses, and bears witness to the fertility of the soil redeemed from the sea.

Since writing the above, I find from a conversation with Professor Shaler that he has been for some time engaged in a study of what he appropriately calls "*the pocketing of sands*" along our coast. He points out several localities in which this operation can be traced, and conceives that the lower harbor of Boston is just beginning to receive supplies in this way.

Value of Tide Lands.—The unimproved salt marshes of Massachusetts, under average conditions of distance from market, and

* Very much the same view that was expressed by Lieutenant Davis.

accessibility during the mowing season, are worth eight dollars per acre. In Delaware and New Jersey, similar marshes, held formerly at about the same price, have been properly diked, and become equal in fertility to the prairie land of the West, and in these States many farmers, investing their capital in such improvements, have seen it restored tenfold. I know a district in Holland, newly drained, that has become the residence of a large community of farmers, who live in comfort and with every indication of health and happiness, although the average area to the individual is only ~~one~~ ^{Hand} half acre.

Tides.—Dean's History, as we have seen, gives "3 to 5 feet" as the rise and fall of the tide at North River Bridge forty years ago, and I am inclined to accept the statement, not only because the author is reputed to be careful in such matters, but also because the recollections of Captain Tolman, and other persons in this very intelligent neighborhood, confirm it. In the present obstructed condition of the river the range of tide at North River Bridge varies from 0.8 to 1.5 feet, and the range does not now exceed these figures at any point above White's Ferry, near which the modern overflows have occurred. The obstructions act as weirs, over which only the upper portion of the tide flows. The highest place in the river bed along the thread of the channel is 1.60 feet below the mean level of the sea, and upon this weir the tide does not rise to the high-water level of the ocean, because of the rush into the reservoir beyond, which does not get filled in the short time allowed.

The following table exhibits the times and heights of a low neap tide:—

Tides of North River.

STATION.	High Water, Interval after Moon's Transit.		Range of Tide, in feet.
	<i>h.</i>	<i>m.</i>	
Cape Cod Bay,	XI.	X.	7.7*
Station 1st,	XI.	XV.	4.7
Station 2d,	XI.	XXX	3.7
Station 3d,	XI.	XL.	1.7
Rogers' Wharf,	XI.	XLIV.	0.8
Little's Bridge,	XIII.	XLII.	0.5†
Union Bridge,	XIII.	LIX.	0.6
North River Bridge,	XIV.	XXX	0.8

* Spring range = 10.58.

† Spring range = 1.1.

The obstructions in the lower reach of the river do not protect the marshes from an inundation on the occasion of a great *general rise*

outside, because, after the river mounts two or three feet above ordinary high water its section becomes very ample all the way from the sea. But the obstructions play their part in preventing the prompt relief from inundation, since, with the subsidence of the *general rise* outside, the sections at the obstructions return to their ordinary dimensions and the outlet is choked. What is true of inundations due to "general rise," is also, in a measure, true of every spring tide. The high-water volumes flow easily up the river into the Fourth Cliff Bay, but are so delayed that when they would return to the sea they find that the fall of the tide has left but a contracted section in the lower reach of the stream, and, although this becomes the scene of a torrent during the low stages of the outside tide, the relief is not afforded for several days. It is especially at the season of hay-cutting on these meadows that the prolonged inundations become injurious; and Captain Tolman informs me that an increase in their durations has been observed, and much commented upon by persons whose memories go back to better times.

Of course the order of the tidal currents is very much affected by the tendency of the obstructions to limit the supply of tide-water in the reservoirs during the rise, and pond it back during the fall. The flood current, although it does not begin to run in over the shoals until it lacks but about two hours and a half of high water, continues about one hour and a half after the tide has begun to sink. The ebb current continues about eight hours, and runs most rapidly about the time it is low water in the sea. You will perceive that the flood and ebb, the one pouring in at high water, the other struggling out at low water, cannot be properly compared by their durations alone, but their volumes must be considered since the sections are unlike. Here is a case where "Prof. Peirce's criterion" is not applicable, for obvious reasons, and it becomes necessary to compute the fresh-water supply from actual gauging. This computation is given in the following table from observations over a short reach just below the shoals:—

Mean Height of Surface.	Time, 23d June, 1870.		Mean Section.	Mean Velocity per second, in feet.	Volume per second, in cubic feet.	Period, in seconds.	Volume, in cubic feet.
	<i>h.</i>	<i>m.</i>	<i>h.</i>	<i>m.</i>			
0.9	5	34	6	00	705	0.4	282
1.3	6	00	7	00	792	1.6	1,267
1.7	7	00	8	00	879	2.6	2,285
1.6	8	00	9	00	857	1.6	1,371
1.2	9	00	9	15	770	0.2	154
Inflow,							18,301,320
0.9	9	15	10	00	705	0.8	564
0.6	10	00	11	00	640	2.4	1,536
0.3	11	00	12	00	575	3.3	1,897
0.2	12	00	13	00	553	3.3	1,825
0.1	13	00	14	00	532	3.1	1,649
0.05	14	00	15	00	522	2.9	1,514
0.0	15	00	16	00	510	2.9	1,479
0.10	16	00	17	00	532	2.2	1,170
0.5	17	00	17	29	618	0.6	371
Outflow,							42,043,700

* Mean L. W. Section 510; mean H. W. Section 879.

† The height of surface is referred to low water, (4.6 below "Primary Bench.")

Effect of a Dam.—From the above table the river discharge may be computed to be 11,871,190 cubic feet during six hours, and this quantity includes any reservation from the preceding higher tides. Now the area of the river surface above the gauging place, and below the North River Dam, is 32,920,470 square feet, exclusive of tributaries and creeks. If upon the day of gauging a dam had been thrown across the stream, the average rise of the river behind it would have been 0.36 of a foot in six hours. As the area of the river surface would be reduced by drainage, the average rise, under otherwise similar circumstances, would be slightly augmented.

The figures I have given are true for the period of my observations, but of course vary with the rainfall at different seasons. My acquaintance with the river is too short to permit me even to conjecture upon what date in the spring the river becomes drainable. On Sept. 29th, just before the beginning of the rains, after the long drought of the past season, my aid, Mr. F. H. North, gauged the river again at Little's Bridge, at the head of Fourth Cliff Bay, and found the flood and ebb currents of nearly equal duration, and the

density of the water as high as 1.017 on the last of the ebb. In effect the stream had become an arm of the sea, without any perceptible rise due to fresh-water.

During the coming winter and spring, opportunities will be offered for examining the conditions of the river under the circumstances most opposed to drainage, and I suggest to the marsh owners an occasional repetition of some of the observations I have detailed in this report—that the whole scheme may be reduced to figures, and not a dollar spent that can be saved, or saved at the expense of success.

The removal of the shoals from the lower reach of the river is the obvious remedy for all difficulties of discharge, but the depth to which the dredging should be carried ought not to be decided upon before observations in the wet season are made. Deepening to the level of mean low water of the sea will be the utmost that can become necessary, and I hope that something even may be saved of this.

In addition to the observations which form the basis of the tide-table given above, we have half-hourly records of the rise and fall at stations simultaneously occupied, so that we can follow all the tidal phases from the sea to the North River Dam. I am obliged to omit, however, these details, because they are too voluminous for this report, and would require long explanation; but I shall venture to comment upon them briefly, to show their practical bearing upon the engineer's project.

I conceive that the engineer, in deciding upon the dimensions of his sluice-gates, may find it necessary to compute the variations of the slope and a study of the progress of the tidal phases will be his best resource. A gate closed upon a stream produces an effect like that of the rising tide at slack water, and the rise due to the closure is propagated at the same rate (essentially) as that of the tide. In a similar way, the depression caused by the opening of a sluice-gate falls back like the tide. With the North River at the level we found it, the rise on the closure and the fall on the opening of a sluice-gate at White's Ferry, would affect Fourth Cliff Bay in about one hour, the neighborhood of Little's Bridge in one hour and fifty-eight minutes, and the neighborhood of North River Dam in two hours and forty-six minutes. The duration of rise or fall would everywhere be equal to the time of closure or opening, so that at North River Bridge the water would sink for two hours and forty-six minutes after the gates were closed, or rise two hours and forty-six minutes after the same were opened. Fourth Cliff Bay

* An indispensable computation, if freshets are to be provided for.

performs the function of a reservoir, and the sluice-gates should be placed as short a distance below as other circumstances will admit.

The marsh owners, both at Scituate and Marshfield, have wisely selected Clemens Herschel, C. E., to draw up plans of construction.

GENERAL CONCLUSIONS RELATIVE TO THE PROJECTS OF RE-CLAMATION.

First. The marshes of Green Harbor River may be drained by the construction of a sluice-dam at Turkey Point without unusual precautions or expense, but not without injury to the present facilities for navigation below said point.

Second. The North River marshes can be drained by constructing a sluice-dam at White's Ferry, provided the present obstructions below are removed by dredging; and provided also, that dikes are carried across the "slue-ways" of the beach, to the height of thirteen feet above mean high water of the sea.

Third. The dams, to escape overflows from the "general rise" during storms, must be carried at least four and a half feet above mean high-water of the sea.

Fourth. The marshes, after drainage, will not sink or shrink more than twelve per cent. of their elevation above the water-table.

PERSONAL.

In the prosecution of my physical surveys in this section, during the past season, I have been assisted by volunteers from the Massachusetts Institute of Technology. To Mr. Hoyt (instructor), and to Messrs. Pike, Stone, Howland and Curtis (students), whose admirable training at the Institute fitted them for immediate usefulness, I am much indebted for the accuracy of my observations, and for the rapidity with which my work was performed.

My aid, Mr. F. H. North, commenced this season his study and practice of surveying, and served me both upon the Atlantic and Pacific coasts, with an energy and good will, that afforded me great satisfaction.

* * * * *

HENRY MITCHELL,

Chief Physical Hydrography, U. S. C. S.

To Prof. BENJAMIN PEIRCE,

Superintendent U. S. Coast Survey.

REPORT OF PROF. WHITING.

PROFESSOR BENJAMIN PEIRCE, *Supt. U. S. Coast Survey.*

DEAR SIR:—In fulfilment of your instructions I have had made under my personal supervision, by Mr. O. H. Tittmann, of the U. S. Coast Survey, a survey of North River, in Plymouth County, Mass., including the upper reaches of the river from the limits of the former shore survey by Assistant A. M. Harrison, to the head of tide-water.

The importance of a complete survey of this portion of the river was first brought into notice by the action of the State Board of Harbor Commissioners in connection with the proposed scheme for the reclamation of the marshes which occupy the valley through which this river flows.

Your orders directing a coast survey party to execute this work, not only furnishes the desired data as a basis for the reclamation of these marshes, but also completes a section of important coast topography, and gives the necessary data for determining the relative value of this river as a navigable water.

In the comprehensive report of Prof. Henry Mitchell, Chief of the Physical Hydrography of the Coast Survey, he has solved the problem of the practicability of the drainage of the marshes of this river. His survey of the lower reaches of the river from its opening through the outer beaches to the enlarged section, or basin, above the artificial bar, which he has so elaborately determined, has covered the ground of the physical character and condition of this stream, and leaves but little to report in connection with my own survey of the upper portions of the river, except the simple statement of topographical details, and to present my maps which have been made upon a larger scale, $\frac{1}{50000}$, than that of our ordinary coast survey field work, as a basis for a scheme for the drainage of the upper marshes, and of improvement by shortened reaches and corrected bends in the pathway through these marshes, of the main channel of the river.

In connection with the general subject of my survey, I deem it

my duty to report to you such facts and opinions as have come to my knowledge, bearing on the question of the conversion of North River from its natural condition as a tide-water stream, open to navigation, and once the seat of valuable ship-yards and some commerce, to a closed stream, from which all connection with other ports and waters by way of its channel and outlet to the ocean is essentially cut off.

Several questions present themselves for consideration in connection with the proposed change in the character and function of this river, viz.:—

First. The value of the inlet as a harbor, of the river as a navigable and commercial water, and of the marshes of the valley for agricultural purposes *in their present state*.

Second. The probability, by any natural causes and effects, of the river again becoming navigable, or any material change for the better taking place in the character and condition of its marshes.

Third. The practicability and economy of improving the inlet and the channel of the river so as to render it navigable, and its value for the purposes of maritime commerce and ship building, should this be done.

Fourth. The practicability and economy of shutting out tide-water, and the value for agricultural purposes of the territory thus reclaimed from salt marsh to fresh drained meadow.

In considering the first question named, it will be seen that the mouth of this river opens into the central part of Massachusetts Bay, and upon a straight and unprotected shore, exposed to the full sweep of north-east, east and south-east storms, with no indenture or headland to form any local shelter.

Owing to the limited extent and volume of the waters of North River its inlet is, and must ever be, of small capacity, and subject to change in width and depth by the action of storms upon the sandy bar and beaches at its mouth.

The resultants of the natural forces at work upon the inlet and lower reaches of North River, seem to determine toward a lessening of their depth and a shifting of the inlet southward. The results of Mr. Mitchell's survey show the capacity of the inlet and lower channel to be insufficient for the passage of a vessel suitable in size for the general purposes of freight or traffic. *The inlet, as a harbor of refuge, is of no value.

While the bar at the mouth of the river has increased, and shoals have arisen within the channel above it, the extent and level of the marshes of the general valley remain unchanged and unobstructed. The plane of these marshes is below the range of spring

and high storm tides which continue to overflow the entire valley, while the escape of the surplus water is retarded, and in a measure locked in by the high shoals and bar at the river's mouth.

These occasional excessive floods of salt water are injurious, in their effect upon the grasses of the marsh. It is a natural condition to all extensive tracts of salt marsh, that the margin of the main streams and tributaries, from their more ready drainage, become firmer and even higher ground than the rearward portions, which cannot cast off their surface waters quickly. The result is, that stronger grasses and firmer roots take hold of the best drained sections, which tends still more to keep back the ebbing water, so that in portions of marsh remote from the main streams, the grasses are sometimes entirely killed out by the long standing and stagnant water.

The salt marshes of North River are no exception to this general law, and left to the natural action of the tide will probably never much improve.

This last stated fact answers in part the second proposition: "Is the inlet and river likely to improve by natural causes and effects?" The negative seems the logical answer.

As before remarked, the inlet is evidently working southward, leaving a longer and shoaler channel between the main water basin and expanse of marsh, and the opening at the beach. This increased length of strait diminishes the power and action of the upper sections as a reservoir, when filled, and tends to lessen the probabilities of the natural deepening of the river or the bar.

In considering the third point proposed, the same conditions, influences and effects, bear on the question of artificial operations, which obtain in regard to natural ones.

Already the experiment of an artificial "cut" or opening, through the beach, as an improved mouth for the river, has been tried and has failed.

The excavation of a channel through the shoals of the lower reaches of the river would be attended with vast expense in proportion to the result obtained, and when done, the whole work might be destroyed by the action of a single storm in breaking over the lower portion of the outside beach and sanding up again, and changing the whole physical condition of the outlet of the river.

But should the artificial improvement of the mouth and channel of the river fully succeed, what would it effect?

When ship building and commerce occupied the borders of North River, no railroads or telegraphs controlled the business markets of the country, and the vessels built were of different style

and different size from those of the present day. While it is true that a class of small vessels, such as coasting schooners, &c., might again be built upon the shores of North River, should its navigation be made sufficient for importing the necessary timber, and afterward, for launching the vessels and getting them out at sea, it is equally true that there are many harbors, rivers and waters in Massachusetts now unoccupied, which are more suitable for this business and purpose in their present natural state, than North River would or could be after the greatest improvement practicable.

Any large expenditure of money for the purpose of establishing maritime commerce only, could scarcely be made to pay, and would probably never become of material value to the community settled upon the shores of this small river.

We come, therefore, without a positive result in answer to the preceding questions, to the consideration of the fourth or last point proposed.

I submit that the first part of this question is answered by the results of Mr. Mitchell's observations and physical survey as stated in his interesting and valuable report. These have been confirmed by the study and formula applied by Mr. Clemens Herschel, who has been called upon to give his professional attention to the subject of the drainage of the river, and the construction of a dike and sluice-gates.

It is therefore demonstrated that it is practicable to shut out the tide-water, and to drain the river and the marshes successfully. The feasibility and value of the undertaking alone remain to be considered.

I will not here discuss the question of the result of drainage on the productiveness of these particular marshes. The result in the case of other salt marshes in no way differing from them in character or condition, is a matter of fact too well established to call for a reference even in this Report.

I am not able at this writing to refer to the soil of the marshes of North River, but I have before me specimens of the marsh compound of Green River, but a few miles below, and belonging to the same general coast formation.

Without attempting a scientific or chemical analysis of this material, I will state its general character.

At the surface of this marsh there is a mixture of fine gray sand and mud, with considerable fibrous woody matter. At one foot below the surface the material is similar, with a slightly larger proportion of mud and fibrous roots. At two feet below the surface but little sand, with masses of fibrous roots and mud. At three

feet below the surface a similar compound to the last, with a larger proportion of mud. At four feet below the surface the character of the soil changes, and we find a fine yellow sand with some yellowish mud intermixed.

We have, therefore, the indication of a soil between three and four feet deep, of the richest character, abounding in fibrous vegetable matter and rich soluble earths.

The result of my survey determines an area of these marshes, including the mud flats of the water spaces, which amount to 3,074 acres.

Geographically, this territory is unlike many tracts of salt marsh bordering the main sea-board, which are generally in masses of large lateral extent.

The marsh bed of North River conforms to the general pathway of the stream, and occupies a tract immediately back of the outside beach for a distance of about five miles northward from the mouth of the river. At this point the river bends and trends westward and inland from the shore by a long and narrow valley, which varies in width from about 3,000 to 2,000 feet. In the central part of the valley the average width, for a short distance, is not over 600 or 700 feet. The total length of this tract of marsh above the site of the proposed dike and sluice-gates, and following the general course of the valley and its main branches, is about ten miles. The length of river, following its windings through the marsh from its mouth to the head of its tide-water at North River Bridge in the town of Hanover, is about fifteen miles.

The small lateral extent of the marshes in the upper portions of the valley makes them particularly well adapted to successful and profitable reclamation. The bed and channel of the river becomes a "*main drain*" into which the lateral drains can discharge their surplus waters advantageously.

The course of the river and valley is also of much favor to the community through which it passes, as it winds its way by almost every farmer's door and grounds, giving to the man of few as well as many acres the benefit of its improvement.

The early settlement of this section of the Commonwealth and the constant drain upon the natural resources of the soil have rendered the uplands in this neighborhood hard to till and of scant profit in their culture. There is, perhaps, no community where an acquisition of new, rich and easily cultivated land would be more acceptable than to the inhabitants of the borders of North River.

The already existing branch railroad to Hanover and the contemplated extension of the Cohasset Railroad to Duxbury passing across

the lower part of these marshes will afford unusual facilities for transporting surplus produce to Boston and other markets.

I leave the statistics and discussion of the relative values of such marshes as those under consideration, in an unreclaimed or reclaimed condition. Allusion has been made by Mr. Mitchell, in his report, to the New Jersey and other marshes. Cases abound which prove the value and advantage of such improvement as is now proposed. There seems to be no question, in the case of North River, of the feasibility and desirability of reclaiming its valley by the drainage scheme proposed. And no question between the value of the river for maritime commerce and ship building, and that of the improved marshes as an agricultural district, which must far exceed in value any other use to which they can be put.

GREEN HARBOR RIVER.

In addition to the survey of North River, Mr. Tittmann executed, under my general charge, a survey of the upper part of Green Harbor River, from the limits of the former field work of the Coast Survey by Assistant A. M. Harrison, to the head of the Green Harbor River marshes.

This survey covers the ground included in the scheme of drainage proposed for Green Harbor River, and gives the same data for the details of this work as that furnished by the maps of North River. It also gives the full area of the Green Harbor River marshes which amount to about 1,506 acres.

The physical condition of Green Harbor River and the relation of the marshes to it offer a more simple problem for successful drainage than that offered by North River. The report of Prof. Mitchell fully presents the subjects of the drainage of each of these rivers.

The commerce of Green Harbor River is but of limited amount and of small value, and what there is, seems mostly confined to the lower part of the river. The site of the proposed dike and sluice-gates is above the location of the wharves and landings now in use, so that the portion of the river cut off and appropriated to the purposes of drainage and agriculture will not materially affect its commercial uses.

The navigability of Green Harbor River as affected by its change of physical condition from an open tide-water stream to one closed not far above its mouth by a dike and sluice-gates, is a question of some uncertainty.

The mouth of Green Harbor River differs from that of North River in its local condition and surroundings. The slight indenture in the general shore line and the shoal grounds of Brant Rocks and

High Pine Ledge form a degree of shelter in the approaches and entrance to the river. As a small local harbor it also has some character. Once within the mouth of the river a small vessel would find good anchorage, a sufficient depth of water and complete shelter. The entrance, however, is shoaler than the river within and really cannot be called navigable at low water.

Considered as a commercial port the whole available water is but of small extent.

As a harbor of refuge it will probably never be of use except by local fishing boats and small pleasure yachts of the immediate neighborhood. For coasting vessels generally, or any craft seeking a harbor of refuge merely, the far more accessible and ample harbor inside the Gurnet, but a few miles southward, renders Green Harbor River of no value as a public refuge.

It is questionable whether the construction of a dike and gates, by shutting off the upper reaches of the marsh creeks as a reservoir, will materially affect the river below them, or injure the entrance to it.

But even if this should be the case, at some remote day, the reclaimed marshes will be of far greater value to the local community, and to the town, county and State, as an agricultural district, than any use which can be made of the unimproved waters of the river.

Respectfully submitted.

HENRY L. WHITING,

Chief of Topography of United States Coast Survey.

REPORT OF GENERAL FOSTER.

BOSTON, MASS., January 16, 1871.

HON. JOSIAH QUINCY, *Chairman of Board of Harbor Commissioners:*

SIR,—I have the honor to furnish you with a copy of my report on Boston Harbor, by permission of the Chief Engineer of the army.

Very respectfully, your obedient servant,

J. G. FOSTER,
Brevet Major-General U. S. A.

BOSTON, MASS., January 10, 1871.

Brigadier-General A. A. HUMPHREYS, Chief of Engineers U. S. A., Washington, D. C.:

GENERAL,—As the operations of the year, upon the works of improvement in this harbor, have closed, and as the greater portion of the work accomplished was done during the latter part of the season, and consequently not included in my report at the close of the fiscal year, June 30, it seems to be a proper and favorable time for presenting a comprehensive report of the whole season's work; and also, being of interest in the connection, to give a brief sketch of the plans adopted for the preservation and improvement of the harbor, the progress thus far made in their execution, the results and ascertained facts, and the proper conclusions to be drawn from them.

The natural boundaries of Boston Harbor include all the expanse of tide-water lying within a line drawn from Point Allerton to Point Shirley, and extending from that line westward to the shores of the main land.

This comprises a surface area of nearly thirty-one thousand acres, from which, deducting the area of the islands within the harbor, nearly one thousand acres in extent, gives a water area of the harbor of twenty-nine thousand seven hundred acres. This large expanse is well sheltered from the ocean by Point Allerton and the ten seaward islands, among which the most important are Deer Island, Lovell's Island, and the three Brewster Islands. These islands and the adjacent headlands constitute the natural breakwaters of the harbor, through which the two deep channels—the Main Ship Channel and Broad Sound Channel—pass in such a manner, that all vessels, as soon as they are fairly within the portals of the harbor, are within easy access of well-sheltered roadsteads.

The large interior basin of the harbor is fortunately divided into many excellent anchorages, both for light and heavy draught vessels, by the favorable position of the numerous islands in the harbor. Of the eighteen of these that appear on the chart, the most important in respect to the protection they afford to shipping, are George's Island, Gallop's Island, Long Island, Peddock's Island, Castle and Governor's Islands.

George's Island shelters the shipping in George's Roads from the easterly gales, and also a part of Nantasket Roads from northerly winds. Gallop's Island also affords protection to George's Roads on the north, and to the Main Ship Channel on the west and south-west.

Long Island shelters the President's Roads from the south and south-east storms and George's Roads from the north-west and westerly gales. Peddock's Island protects Hull Basin on the north-west and a large portion of Nantasket Roads on the south. Castle and Governor's Islands afford protection to the "Upper Harbor," as the portion of the harbor lying west of Fort Independence is usually termed, in contradistinction to the "Lower Harbor," which comprises all the water surface extending eastward to the entrances.

The first class anchorages, sheltered by the above islands, for vessels of twenty-three feet draught, at all stages of the tide, are as follows:—

Nantasket Roads, containing	. . . . .	1,720 acres.
Hull Basin, containing . . . . .	. . . . .	730 "
George's Roads, containing . . . . .	. . . . .	490 "
President's Roads, containing . . . . .	. . . . .	1,010 "
Upper Harbor, containing . . . . .	. . . . .	200 "
		<hr/>
Total, . . . . .	. . . . .	4,150 "

The above does not include the areas of the Main Ship Channel, nor the anchorages north of the Lower Middle Ground. It does include the area of the Upper Harbor, because it is now connected with the deep water of the Lower Harbor, a cut having been made by dredging, during the past season, entirely through the Upper Middle Bar, to a depth of over twenty-three feet at mean low water. This cut, now only forty-five feet in width, it is proposed to widen, during the next and following seasons, to three hundred feet; or more, if navigation shall require it.

Nearly all the islands of the harbor are now entirely destitute of trees. A few remain upon Apple Island, and a small number have been planted on George's Island by the Government since the construction of Fort Warren. Yet history and tradition both agree in stating, that at the time of the first explorations by the Pilgrims nearly all the islands were well wooded. Some of them bore evidences of having been inhabited and cleared for cultivation. The new work by Hon. N. B. Shurtleff, entitled "Topographical and Historical Description of Boston," contains many interesting

extracts from old records, showing the impressions made upon the first explorers by the natural advantages of the harbor.

One writer in 1634, says:—

“It is a safe and pleasant Harbour within, having but one common and safe entrance, and that not very broad, there scarce being room for 3 ships to come in board and board at a time; but being once within, there is anchorage for 500 ships. This Harbour is made by a great company of Ilands, whose high cliffs shoulder out the boistrous Seas, yet may easily deceive any unskilful Pilots; presenting many faire openings and broad sounds, which afford too shallow water for any Ships, though navigable for boates and small pinnaces.

“The entrance into the great Haven is called *Nantascot*; this place of itself is a very good Haven, where ships commonly cast anchor, until winde and tyde serve them for other places; from hence they may sayle to the River of *Wessaguscus*, *Neponset*, *Charles River* and *Misticke River*, on which Rivers bee seated many Townes. In any of these fore-named harbours, the seamen having spent their old store of Wood and Water, may have fresh supplies from the adjacent Ilands, with good timber to repair their weather-beaten Ships; Here likewise may be had masts or yards; being store of such Trees as are useful for the same purpose.”

The same writer in 1635, says:—

“These Isles abound with woods, and water, and meadow grounds, and whatever the spacious fertile maine affords,” &c.

It is not remarkable that the great value of the harbor, and the protection afforded to the anchorage grounds by the numerous islands, should have strongly impressed the early explorers. Its natural advantages, strongly impress at the present time, all those who carefully study its physical characteristics.

Professor Henry Mitchell, in a recent unpublished report, says:—

“The great merit of Boston Harbor lies in a happy conjunction of many favorable elements, among which we may distinguish, as most important, the facility and safety of its approaches, the ample width and depth of its entrances, and, above all, the shelter and tranquillity of its roadsteads. Perhaps there is no other harbor in the world where the inlets from the ocean are better adjusted to the amplitude of the interior basins, and whose excellent holding grounds are so easy of access and yet so land-locked. I quote from the highest authority in my profession when I declare that the primary requisite for a good harbor is that ‘*The internal area should bear such a relation to the width of entrance as to produce a sufficient degree of tranquillity,*’*

* Stevenson on Harbors.

and so difficult has it been to properly adjust this relation, in artificial harbors, that nearly one-half of all these works may be set down as failures, because the entrances are either too narrow to admit vessels under trying circumstances, or the interior reservoirs too small to dissipate the waves that run in from the sea.

“In natural harbors where the primary requisite, cited above, is fulfilled, it often happens that the interior basin is so large that the local effects of strong winds are sources of discomfort and even danger—as in San Francisco.

“Boston Harbor has no such drawbacks; her interior water space is large, but is divided by chains of islands into basins, which offer sufficient room for the heaviest ships to ride freely at anchor, and sufficient tranquillity for the frailest fishing boat.”

It does not appear, however, that the early settlers, properly appreciated the value of the *trees* upon the islands, as affording additional shelter to the anchorage grounds, or protection for the islands themselves against the assaults of the winds and waves. The old records are interspersed with permits and votes of towns, authorizing the cutting off the trees and wood upon the islands. The destruction of this natural protection appears to have rapidly progressed. This was a serious loss to the roadsteads, as it deprived vessels of one-half the shelter afforded from the winds by the islands.

To illustrate the estimate that would be placed upon the loss of such protection, in the present era of large ships with lofty masts and heavy spars, I again quote Professor Mitchell, in saying,—

“There are times when shelter from the wind is scarcely less important than smooth water. In the harbor of Cherbourg, the inrun of the waves is most effectually arrested by the great mole, and yet nearly every vessel that sought its shelter in the gale of 1865, was driven on shore by the wind.

“Here, again, Boston Harbor claims peculiar advantages. Her moles are promontories and islands rising from twenty to one hundred feet above the sea, so as to shelter the hull of a ship and much of her top-hamper.”

The extent of the loss to the *islands themselves*, may be estimated from the amount of the resulting injury. Their sides being left exposed to the full force of the winds and their shores to the cutting and dissolving action of the waves, intensified by the lower sweep of the winds, were subjected to gradual destruction.

The effect of the waves in storms, dashing against the exposed shores, is evident to any observer: portions of the material of the formation are dislodged by every dash of the waves; the lighter particles being borne back by the receding waves or undertow, are

either deposited at once in front of the abraded bluff, or are carried away by the currents to other points where, becoming checked in motion, they are deposited to form bars or shoals encroaching upon the roadsteads or channels.

The portions of the material, too heavy to be borne by the currents, are sometimes *driven* by the force of the waves, along the shore, until the moving forces cease or are neutralized.

As the lighter material is washed away, the boulders fall out, and rolling down to the foot of the bank, remain there, forming in time an apron of stone, to serve as a protection against further encroachments. Thus the very process of destruction produces, in time, a protection against itself.

But the removal of these water-worn and rounded stones to serve as ballast or paving-stones (which was prohibited by law on Bird Island, in June, 1818, but not prohibited on the other islands until June 6, 1856), necessarily exposed more of the bank to be washed down, until a new crop of stone was produced.

Whatever the precise character of the *causes* of destruction may have been, the *results* soon became so apparent as to attract public attention, and to alarm those interested in the preservation of the harbor.

Some islands were found to have been entirely washed away, leaving dangerous shoals in their places. *Ram's Head*, a small island situated 550 yards north-east of the north head of Lovell's Island, and containing several acres, had entirely disappeared, leaving one of the most dangerous shoals at the Broad Sound entrance. Upon this shoal, about forty years ago, the Maine Packet was wrecked, and all the passengers, fifteen in number, perished of exposure and cold.

Nix's Mate, once a considerable island according to the old colony records, which show, that on the 8th of September, 1636, "There is twelve acres of land granted to John Galop, upon Nixes Island, to enjoy to him and his heirs forever, if the island be so much." Des Barre's Chart of the survey of 1769 shows Nix's Mate to have been, at that time, an island containing about six acres. This island was long since washed away, leaving in its place a shoal, in close proximity to the main channel, upon which many vessels, each year, run aground.

Bird Island shoal, in the upper harbor, was once an island, and inhabited in 1634.

This washing away of the islands and headlands early called attention to the necessity of the preservation of what remained, and for this purpose the aid of the general government was invoked.

In the year 1825, upon the petition of the city of Boston, and by the exertions of the senators and representatives in congress, an appropriation of \$40,000 was obtained for the protection of Deer and George's Islands,—which was, however, exhausted in protecting George's Island.

In 1828 an appropriation of \$87,000 was obtained for the construction of a sea-wall for the protection of Deer Island; and a dry stone wall was built on the east side of the island, in three sections, covering the three prominent headlands. Subsequent appropriations for the repairs and rebuilding of this wall were made by congress.

In 1843 an appropriation of \$15,000 was obtained, and expended by Colonel Sylvanus Thayer in the construction of a sea-wall on the north head of Lovell's Island.

Other appropriations were subsequently made for this island and Great Brewster Island, on each of which substantial and costly sea-walls have been built and maintained by the general government.

These islands, being the larger of the seaward islands, were the first to receive the attention of the government in the way of protection.

But the islands lying more westerly in the harbor were justly regarded as also requiring protection, being important as the more immediate shelters for the safest and best anchorages.

At the request of the City of Boston, the general government, in 1860, appointed a board of commissioners to examine Boston Harbor. This board consisted of General J. G. Totten, Chief Engineer U. S. A.; Professor A. D. Bache, Superintendent U. S. Coast Survey; and Commander C. H. Davis, U. S. Navy.

Under the direction of this board, but at the expense of the city of Boston, extensive hydrographical and physical surveys of the channels and shoals, and topographical surveys of the shores of the islands, were made by Coast Survey officers.

From these surveys were prepared elaborate and detailed maps and tables of results, clearly showing the injurious changes that had taken place, and indicating the measures necessary to be taken to check them.

These surveys and results were from time to time, from 1860 to 1866, communicated to the city government of Boston in carefully prepared and elaborate reports. In these reports the commissioners strongly urged the construction of sea-walls for the preservation of the prominent headlands of the harbor, using, in the second report, the following strong language to express their convictions:—

"First, that injurious changes are going on unceasingly; and second, that the time is approaching when those who are responsible for the preservation of Boston Harbor must make up their minds either to abandon the lower harbor to its fate or to make immediate application of the remedy—and the only remedy—by which the progress of these injuries can be arrested. This remedy is manifestly the continuation of the old and the construction of new sea-walls; a proper grading of the hills, and a planting of a suitable grass or shrub on the unsheltered surfaces."

Professor Henry L. Whiting of the U. S. Coast Survey, who made the above topographical surveys, arrived at some interesting conclusions as to the probable original extent of the prominent headlands and islands, by completing the contour curves in a manner analogous to the curves of existing hills in the neighborhood. According to his estimates, the "Little Hill" of Point Allerton originally extended to beyond the present position of the beacon, and was about one hundred feet high. It was at the date of the survey reduced in height to sixty feet, and had lost, by washing away, nearly forty-three acres. The loss in thirteen years—from 1847 to 1860—had been twenty-two thousand square feet. The loss of the "Great Hill" of Point Allerton had been in thirteen years—from 1847 to 1860—forty thousand square feet. The Great Brewster Island had lost over thirty-two acres, the encroachments extending to the summit of the largest hill. Two hundred and twenty thousand square feet had been washed away in the thirteen years preceding 1860. Deer, Lovell's, Gallop's, Long, and the other islands, had all lost by washing away in a similar manner, but many of them in a less proportion.

The Board of Harbor Commissioners, organized by the legislature of Massachusetts in 1866, took up the matter with active interest, and caused carefully prepared plans and estimates to be made of the cost of sea-walls, and of deepening and widening the main ship channel by dredging, and the removal by blasting of dangerous rocks lying in the channel. These plans and estimates were forwarded, with a petition to congress, to the chief of engineers (yourself), by whom those for the most important objects, viz.: sea-wall for Point Allerton, Gallop's Island and North Head of Long Island, dredging off the south-west point of Lovell's Island, the west extremity of the Great Brewster Spit, and the Upper Middle Bar, together with the removal of Tower and Corwin Rocks, were approved and recommended to the secretary of war, by whom they were also approved. By these approvals, and the exertions of the Harbor Commissioners and representation of the State in Congress,

an appropriation was at once obtained from Congress of three hundred and seventy-five thousand dollars, three hundred thousand of which were for the new works estimated for, and approved by you, and which were placed in my charge.

In 1868 Congress further appropriated \$33,000; in 1869, \$83,000, and in 1870, \$100,000 more, making in all, in four years, the amount of \$516,000 for these new works.

The *Progress* made up to the present time in these several works, in my charge, is as follows:—

Removal of the Rocks in the Channels.

In 1867 operations in drilling and blasting "Tower Rock," situated one hundred yards south-west from the Great Brewster Spit Light, resulted, after a few months of successful work, in its reduction to a depth of twenty-three feet, at mean low water. Operations were then commenced on "Corwin Rock," situated one hundred yards south-west of Tower Rock. This being a much larger rock, work was continued during the whole season of 1868, and again in the summer of 1869; in the month of June of which year its entire removal to the depth of twenty-three feet at low water was accomplished. Operations were then commenced on "Barrel Rock," a boulder lying in Broad Sound, about one mile a little north of west from Green Island, and near the sailing line of the Portland and other Maine steamers. Having only four feet of water upon it at low tide, it constituted, in thick weather, a dangerous obstacle to navigation. It was successfully blasted, and the fragments were all removed to the shore or into deep water.

Operations were then commenced on "Kelly's Ledge," a rock with sixteen feet of water upon it, lying in the main ship channel, directly in the line from the entrance buoy to the Spit Light. Heavy draught vessels being obliged to pass either to the right or left of this rock, necessarily incurred considerable danger, in foggy weather, from the proximity of the extensive "Centurion Rocks" on one side, and of the Beacon Rocks, near the edge of Brewster Spit, on the other. The season closed when about one-half the work on this rock was completed. It was resumed the past season and diligently prosecuted; but owing to the very unfavorable character of the rock, being a soft slate, with contorted laminations, filled with crystals of sulphuret of iron (iron pyrites), which impeded the action of the drill, the progress of the work was necessarily very slow. The heaviest charges of powder and other explosives used, failed to produce much effect upon the soft rock.

The work was stopped on the 30th of December on account of the weather, and before three high points, left by the blasts, had been reduced to the required level of twenty-three feet at low water, although the general surface was below that level.

These points have now twenty-one and a half feet of water at low tide upon them, and can easily, in a few days of favorable weather, be blasted down to the requisite level. The removal of this rock secures a great advantage to navigators in enabling them to make one straight course from the entrance buoy to the Spit Light.

The Great Brewster Spit.

No attempt has yet been made to cut off by dredging, the west extremity of this spit; because, during the removal of Tower Rock, the divers observed and reported, that the rock rose in a gradual ascent towards it and evidently formed the backbone of the spit, the projection or ridges being outcroppings of the general ledge of rock underlying this part of the harbor, running in a north-east and south-west direction, and forming the foundation of the seaward islands "whose high cliffs shoulder out the boistrous seas."

The deposits at the end of the spit have not, as yet, reached such deep water as to render their removal by dredging absolutely necessary. Its present growth, as reported by the light-keeper, is towards the west and south, and has been quite rapid within a few years. The supply of material for its growth appears not yet to be entirely cut off by the completion of the Great Brewster Sea-wall. The angle of that wall, on the east side, near the large hill, being very near the bluff, appears to permit the waves,—when they have gathered force by being compressed in the re-entering angle,—to mount the wall and dislodge large masses of the steep bank. This will probably continue until all the earth that can be reached by the breaking waves is washed away; or until the bluff is graded into a slope suitable to resist the action of the seas.

I do not therefore think it advisable to expend anything, at present, in dredging the extremity of the spit, but to await the ultimation of the effects of the causes still remaining in force.

Widening the Main Ship Channel by Dredging off the South-west Point of Lovell's Island.

This work was commenced in 1868, and continued in 1869; the whole point was cut off for a width, in a direction perpendicular to the axis of the channel, of two hundred and sixty feet, from the top of the bank, in a regular slope, to the depth of twenty-three feet at low water. This has caused a slight increase of the ebb

scour through the Narrows, which has appreciably enlarged the widening, and smoothed off all projecting ridges left in the hard bottom by the buckets of the dredges.

This improvement has widened the channel at this point, at the depth of the eighteen feet curve, from its former width of three hundred and sixty-five feet, to six hundred and twenty-five feet, a gain of two hundred and sixty feet.

Nothing more, in my opinion need be done at this point of Lovell's Island; but I propose to dredge off the extremity of a shoal making out from the east side of Gallop's Island, on the opposite side of the channel. Upon this spit, called Cape Cod Shoal, many vessels get aground at low water, and it is a much needed improvement to dredge off its point in a line parallel to the axis of the channel, so as to make the channel as wide at this point as it now is at other places.

Dredging a Channel through the Upper Middle Bar.

The peculiar character of the material of this bar—a very hard, indurated yellow clay (hard pan),—prevented the different machines that were successively tried during the three past seasons, from succeeding. During this season, however, Mr. E. A. Seward of Albany, the contractor, with the assistance of Mr. C. H. Montine as sub-contractor, has succeeded in making one straight cut, two thousand two hundred feet in length, entirely through the bar, to a depth of twenty-three feet at low water, and a width of sixty feet. This cut is marked by three spar buoys. Eighteen thousand six hundred cubic yards of material have been dredged and dumped during the season. The widening of this cut will be continued during the next season, in which it is expected a width of three hundred feet will be obtained.

Sea-Wall at Gallop's Island.

The construction of a wall for the protection of the north and east sides of this island was commenced in 1868, and continued in 1869 and 1870. The wall proper was completed about the middle of October last. The earth backing has been filled in for about two-thirds the length of the wall, and its west end has been connected with the bank by a short dry wall, with an apron of stone in front. The stone for the flagging to be placed back of the coping course, is on hand, ready to be laid during the coming season. The character of this wall is shown in the accompanying sketch. It has a strong granite facing of headers and stretchers, with dovetailed joints, and a compact concrete backing. Its height varies from

fourteen to seventeen feet (having an extra course at the bottom for a portion of its length). Its thickness is nine feet at bottom, and five feet at top. Its foundation is a compact mass of concrete three feet thick, and thirteen and a half feet wide. This foundation is laid in a trench excavated to an extremely compact stratum of gravel and clay, or hard pan. It is located nearly on the line of ordinary high water. The total length of the wall is 1,745 running feet.

The appropriation called for in the annual report of June 30th, 1870, is much needed to complete, in the next season, the back filling of earth, to lay the granite flagging back of the coping, and to slope down and grass the steep face of the bluff.

Construction of Sea-Wall at the North Head of Long Island.

Operations were commenced by the contractor, Mr. James Andrews, about the middle of August last, and continued during the season. A wharf for landing materials was constructed by him at the north-west point of the head, from which a railroad track was laid to the location of the wall. A cement-house was built by me, and quarters for his men were erected by the contractor. During the season the foundation course for five hundred and twenty-four feet in length of the wall was built, and three courses above the foundation laid, to nearly the same extent. A large amount of material is on hand ready for the next season's work. This wall is to be of a character similar to that of the Gallop's Island sea-wall. Its cross section is seen in the accompanying sketch.

Sea-Wall for the Preservation of Point Allerton.

This exposed and rapidly disappearing headland should, from its important character, have been protected at the earliest possible day; but, owing to the numerous delays in obtaining a deed of the site, and the privilege of locating in a safe place the wharf for landing materials, the work of construction was not commenced until this season.

A wharf four hundred and seventy feet in length, extending to the channel, was built on the south and sheltered side of Stony Beach, and a cement-house was erected near by. A railroad track for conveyance of materials was laid by the contractor, Mr. James M. Andrews, from the wharf to the site of the sea-wall, a distance of four thousand two hundred feet. Quarters for his men, and sheds for material and tools, were erected by the contractor.

These preliminary labors occupied so much time that the first pit for the foundation was not started till the last of September, and the work continued only till the first of December. In this

time three hundred and twenty-two feet of foundation, and of the two first courses of the wall, were laid, and backed with concrete and earth.

This wall is similar in character to the Gallop's Island sea-wall, but is made stronger and higher on account of its exposed situation. Its cross section is seen in the accompanying sketch. It is located nearly on the high-water line, and its foundation is placed at a greater depth and upon the same kind of "hard pan" substratum as that obtained for the other sea-walls. It is to be of sufficient length to inclose the face of what remains of "Little Hill." The appropriation asked for will complete the wall proper in the coming season. It is hoped that these timely preservative means to save the remains of "Little Hill" may also arrest the washing away of "Great Hill."

Point Allerton, one of the most marked and prominent headlands that meet the eye of the mariner in approaching the harbor, will thus be preserved nearly in its present distinctive characteristics. The only alterations will be in the features of "Little Hill," and will consist of the substitution of the profile of the sea-wall, terminating in a graded and grassed slope for the present sharp outline and seamed face.

It appears from the directions on the Coast Survey chart, under the head of ranges, that this headland is a useful guide for avoiding the dangers of Harding's Ledge when passing to the southward of it in entering or leaving the harbor.

"Point Allerton Bluff," says Professor Mitchell in his recent letter to the Harbor Commissioners, "remembered first and foremost in your prayers to Congress, is the *pier-head* of the natural mole that defends the lower roadsteads. If it were suffered to waste away the Hull basin would be utterly ruined; and as the opening of the harbor widened, the other anchorage grounds would become unsafe.

"Within the past thirty-eight years the French government has expended some *eight and a half million of francs* for the shore protections of the neck of land which forms the *leeward* point of the embouchure of the Gironde. The reasons assigned for this expenditure were that the point, by falling back, threatened to expose the roadstead of Verdon, and that the pass into the ocean would diminish in depth if suffered to expand."

Comparison of Surveys.

In seeking to ascertain where the materials washed away from this point have been carried, and if any have been deposited in the

main channel, I caused a careful comparison of all the surveys from 1769 to the present time to be made.

The results of this comparison, exhibited in the comparative map accompanying my letter of April 13, 1870, show that within the limits covered by the comparative map, extending about 2,000 feet outside of the entrance and 5,000 feet within, covering an area of the main channel of 451 acres, there has been a shoaling to the extent of nearly *five millions of cubic yards of material*. Were this immense quantity spread out over Boston Common it would cover it to the depth of *sixty-four feet*.

This great deposit did not, probably, all come from Point Allerton; in fact, its source can only be ascertained positively by an accurate and minute geological survey, as recommended by Professor Agassiz in his letter of September 11, 1867, published in the Coast Survey report for that year.

But the movement of the curves of depth outwardly towards the channel is a strong indication that most of the shoaling came from the point.

This outward movement is very decided in the twelve, eighteen and twenty-four feet curves, the latter curve having moved out about *one thousand feet*. The deeper curves have moved less; some of the deepest ones have, however, been entirely obliterated, as for instance the forty-eight and fifty-four feet curves shown on Wadsworth's map of 1817 about half-way between Point Allerton and Boston Light, which are entirely wanting on the Commissioners' map of 1863. The importance of the construction of a sea-wall to preserve Point Allerton, and to shut off this source of supply of material for the shoaling, is thus rendered clearly manifest.

Conclusion.

During the few years that I have had charge of the works of preservation and improvement of the harbor, I have had the advantage of being intimately associated with the Board of Harbor Commissioners of Massachusetts, and Professors Mitchell and Whiting of the Coast Survey, both of whom have been connected with this subject from the first surveys of the United States commissioners to the present time, and are thoroughly acquainted with the details and scope of the original plans.

The *general principles*, as I understand, which guided the United States commissioners in their original investigations and reports upon Boston Harbor, and which likewise actuated the Harbor Commissioners of the State in their exertions and petitions for national aid, were those of *preservation and compensation*; and aimed *first* "to preserve

the great physical features in their ancient order, and to hold on to the old landmarks"; and *secondly*, to compensate, as far as possible, for the evils already caused by a neglect of the above principle, by widening, deepening, and removing obstructions from the main channels.

Their reasons for preserving the prominent headlands and islands were threefold: first, because of their value as *shelters* to the anchorage grounds; second, because if washed away, much of their material *must be deposited somewhere in the roadsteads and channels*; and third, because "as these bluffs fall back they *leave in their places dangerous shoals and reefs*, hidden for the most part, especially at high tide, and these embarrass the navigator, even when he is familiar with their existence and whereabouts."

My own observations and investigations have confirmed my first impressions of the wisdom of the views thus originally entertained; and have convinced me that the carrying out of the proposed plans,—at least, to the extent of the prompt completion of such of the proposed works as have received your endorsement and are now in progress,—is absolutely necessary for the preservation of this harbor, which is justly regarded as one of the most important upon the whole Atlantic coast.

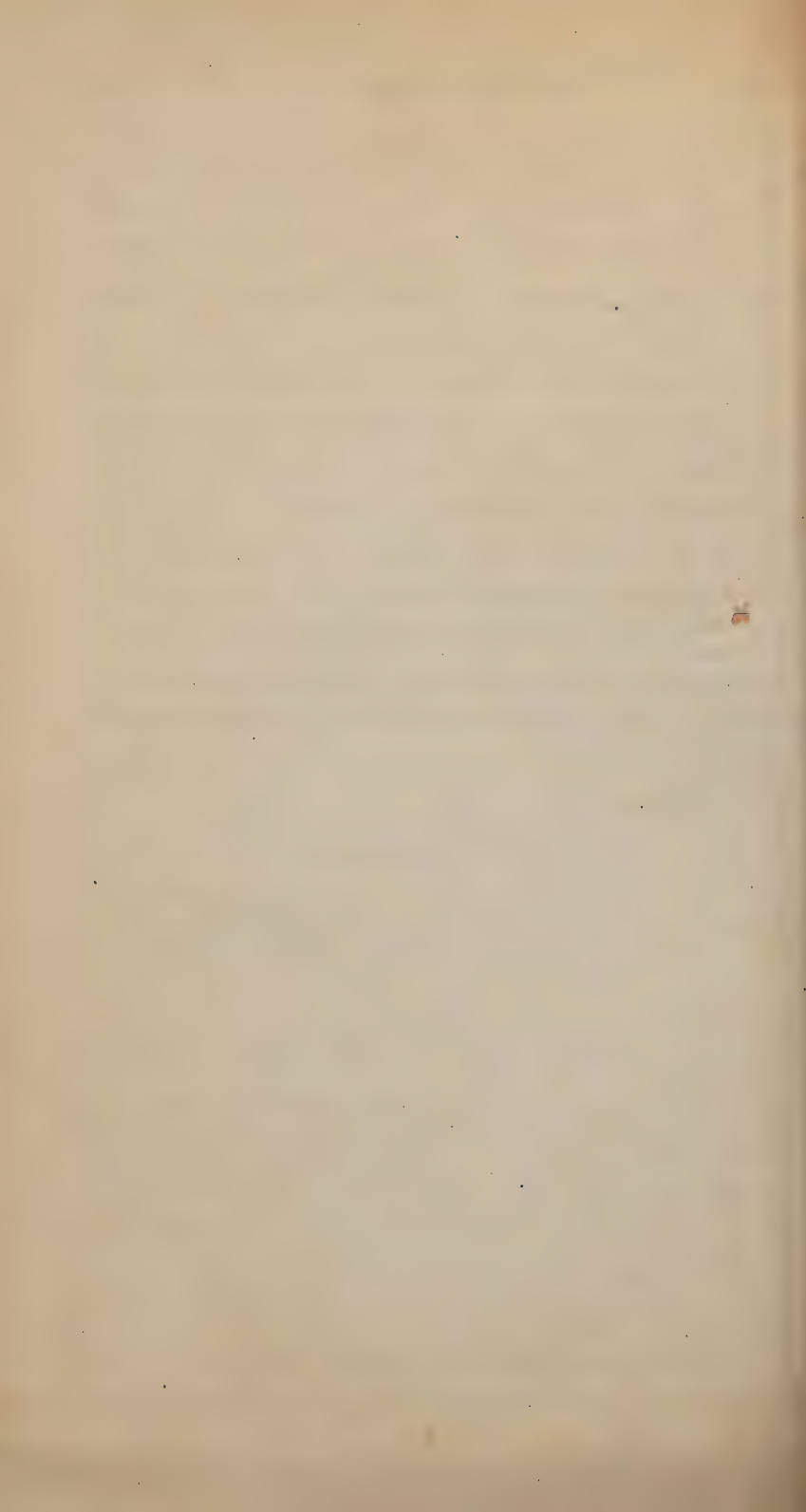
I have the honor to be,

Very respectfully,

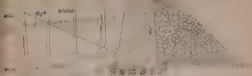
Your obedient servant,

J. G. FOSTER,

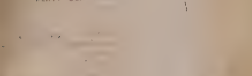
Lieutenant-Colonel Engineers.



South Boston Flats
LIGHT SEA WALL.



South Boston Flats
HEAVY SEA WALL.



EAST BOSTON

PLAN

for the occupation of

FLATS OWNED BY THE COMMONWEALTH

BOSTON HARBOR.

APPROVED AND ADOPTED BY THE GENERAL COURT

AND MODIFIED ACCORDING TO CHAPTER TWO, ACTS OF 1888.

MADE PERMANENT



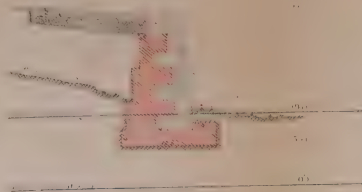


Fig. 11

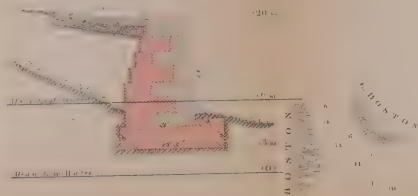


Fig 111.

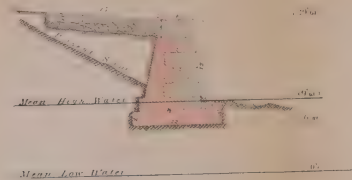


Fig. IV

KELLY'S ROCK

Sketch showing works in the

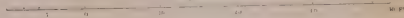
MAIN SHIP CHANNEL

LT. COL. J. G. FOSTER Corps of Eng^{rs}

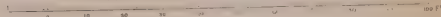
in 1870.

Scale of miles for General Plan 1:40 000

Scale of feet for Figs. I, II & III 10 feet to 1 inch



Scale of feet for Fig. IV. 20 feet to 1 inch

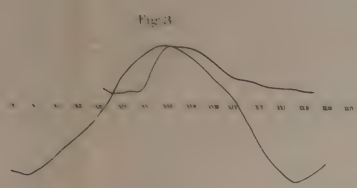
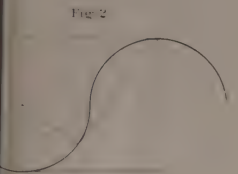
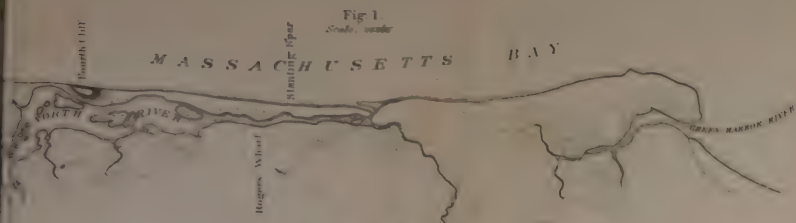


General Plan

Note: The solid line represents the BH curve
74 readings are expressed in lithams
12 are channel inside the BH curve, in line
at mean low water

Legend



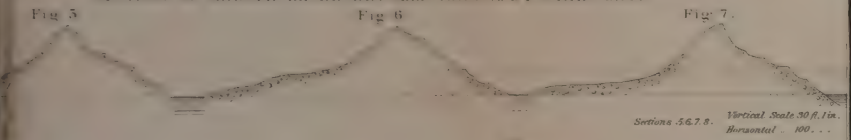


SECTION CROSSING GREEN RIVER AT TURKEY POINT, MASS.

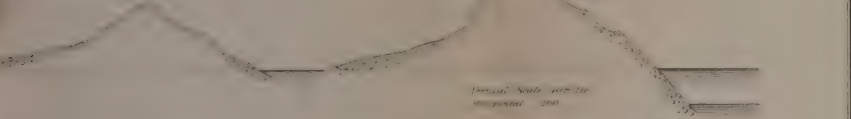
Fig. 4.



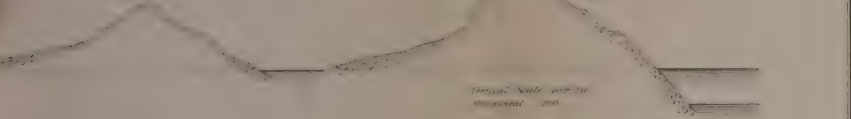
SECTIONS OF SHINGLE LEVEE BETWEEN THIRD AND FOURTH CLIFFS



MEAN OF SECTIONS.
Fig. 8.

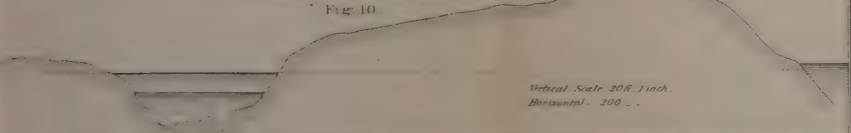


SECTION OF CHESIL BANK ENG.
Fig. 9.



SECTION OF SAND BEACH AT SLANTING SPAR.

Fig. 10.







SIXTH ANNUAL REPORT

OF THE

BOARD OF HARBOR COMMISSIONERS.

—
JANUARY, 1872.
—

BOSTON:
WRIGHT & POTTER, STATE PRINTERS,
79 MILK STREET (CORNER OF FEDERAL).
1872.

Commonwealth of Massachusetts.

REPORT OF THE COMMISSIONERS.

*To the Honorable Senate and the House of Representatives of
the Commonwealth of Massachusetts.*

The Board of Harbor Commissioners respectfully submit
their Sixth Annual Report.

SOUTH BOSTON FLATS.

It has been impossible to make any progress in the actual occupation of the State flats at South Boston during the past year. On the 20th of July, 1869, the Board, with the approval of the governor and council, sold to Messrs. Harvey, Whitney and Groves, trustees of the Boston, Hartford and Erie Railroad Company, about twenty-five acres of these flats situated at the junction of Fort Point Channel and the main channel of Boston harbor, taking a mortgage back to secure the purchase money, amounting to \$545,505.

Previously to this, the Boston Wharf Company had sold to the same trustees, with other territory, about twenty-two and two-thirds acres of flats on Fort Point Channel adjoining these twenty-five acres of the State, taking a mortgage back for the purchase money. On the 8th day of December, 1869, fifty acres of South Boston flats lying south-east of those sold by the State and by the Boston Wharf Company respectively to the trustees of the Boston, Hartford and Erie Railroad Company, were sold

by the Board, with the same executive approval, to the Boston and Albany Railroad Company, for \$445,600, payable in three years from the date, the company to have six years to fill them with material for the most part to be taken from the harbor, and the title to remain in the Commonwealth until the flats were filled. The purchase money, therefore, will be due on the 8th day of December next.

These sales by the Board were made under the authority of chapter 326, statutes 1868, which is still in force.

The Boston, Hartford and Erie Railroad Company bound itself to the Commonwealth, by an agreement secured by the mortgage for the purchase money, to enclose with a wall and fill to grade 13 with material taken from the harbor, not only the flats purchased of the State, but those purchased of the Boston Wharf Company; and they prosecuted the work until the latter part of the year 1870, when the company failed and the work was arrested.

On the 1st day of September, 1871, the Boston Wharf Company resumed the title to its flats by a sale under its mortgage. The Commonwealth resumed the title to its flats on the 14th day of December, 1871, by a sale under its mortgage made by the treasurer and receiver-general under the authority of chapter 372, statutes 1871. The Boston Wharf Company has been for some months energetically at work filling its flats with material taken from Fort Hill.

This company obtained the right to fill its flats without being required to take material from the harbor beyond what is necessary to dredge out a portion of Fort Point Channel to twelve feet below mean low water, as a part of the compromise by which it ceded to the State, certain rights of wharfage on the eastern line of its flats, and about a third part of the flats claimed by it under what it alleged was a grant of the State under chapter 455, statutes 1855, and under the adjudication of the supreme judicial court in the case of Attorney-General *vs.* Boston Wharf Company, 12 Gray, 553. The State also claimed these flats under chapter 354, statutes 1867, which revoked the license given to the company by the Act of 1855.

This compromise of these conflicting claims was effected by the agreement contained in the fourth annual report of this Board, on the 65th page. The Boston and Albany Railroad

Company deposited, in the year 1870, about 167,000 cubic yards of filling upon its tract, but has done nothing more. The Board has had no opportunity, since the State recovered its title under the sale of the 14th day of December last, to make a new disposition of them.

By chapter 91 of the Resolves of 1871, the Board is instructed, after consultation with the governor, the Boston and Albany Railroad Company and the Boston Wharf Company, to prepare a plan for the development and improvement of the flats of the Commonwealth near South Boston, in which development and improvement the Commonwealth and said companies may coöperate.

This language of itself might reasonably lead to the inference that the legislature, being dissatisfied with its present plans for this improvement, desired to have a new one submitted to the next general court for its action. A subsequent Act, however, of the same legislature, chapter 397, statutes 1871, as if to guard against such a construction, provided that nothing contained in this Resolve should be construed to suspend action under chapter 326 of the Acts of the year 1868.

This Act of 1868 is the Act which, in connection with chapter 81 of the Resolves of 1866, establishes the plan for the improvement of the flats of the Commonwealth in South Boston. Of course, if the legislature did not intend that the execution of this plan should be suspended, it cannot be supposed to have intended that the new plan to be reported should be other than in furtherance of the execution of the old one.

Assuming the Resolve to contemplate action merely for securing the coöperation of the Boston and Albany Railroad Company and the Boston Wharf Company with the State in carrying out this improvement, there would seem to be no locality where there is occasion for this coöperation except in relation to the filling of the twenty-five acres of the State flats bounded on the south-west by the Wharf Company's flats and on the southeast by those of the railroad company. And with reference to this tract, the Board had already secured guarantees of the coöperation of these companies before the passage of the Resolve.

In the contract with the Commonwealth made by the Boston and Albany Railroad Company are these provisions :—

“But said party of the second part (*i. e.*, The Boston and Albany Railroad Company) shall, whenever required by the Board of Harbor Commissioners, fill on any portion of the westerly line of said parcel of flats simultaneously with the progress of or after the filling or other occupation there on the easterly line of the westerly adjoining flats conveyed by said Commonwealth and the Boston Wharf Company to said Harvey, Whitney and Groves.”* (Fourth annual report, p. 103). “And said party of the second part, for the considerations aforesaid, hereby covenants and agrees with the party of the first part, that it will fill up as aforesaid that portion of the flats to be conveyed to said party of the second part, upon which the party of the first part (*i. e.*, the Commonwealth) shall locate northern and eastern avenues, and the extension or continuation of B Street as herein provided, whenever required by the Board of Harbor Commissioners, with the assent of the governor and council, and that whenever the Commonwealth, by its Harbor Commissioners or otherwise, shall authorize the filling of the flats on the easterly line of said parcel herein before described, and the work of such filling shall begin, the said party of the second part will fill the flats on such easterly line, so far and at such time as the Harbor Commissioners may prescribe for the protection of the filling of the adjoining territory.” (Fourth annual report, pp. 103-104.)

The Boston and Albany Railroad Company further agrees to build its sea-wall on the outer border of its flats, “and unite said wall with the sea-wall built on a line one foot within said exterior line, and on said adjoining westerly parcel of flats conveyed by the Commonwealth to said Harvey, Whitney and Groves, trustees, so that both walls shall form a continuous and uniform structure.”

These obligations on the part of the Boston and Albany Railroad Company were still in full force, and secured all the coöperation that could be reasonably desired on the part of that company in the improvement of the Commonwealth's flats in South Boston, unless the company would buy more flats.

The Boston Wharf Company executed to the Commonwealth, on the tenth day of April last, an agreement, which was printed for the use of the legislature then in session, by which it agreed that whenever the city of Boston would contract to build in two years a bridge over Fort Point Channel, in extension of Eastern

* Trustees of the Boston, Hartford and Erie Railroad Company.

Avenue, it would build its wall on Fort Point Channel, provided the State proceeded to build its wall enclosing its flats below and adjoining.

The company further agreed to have its flats filled in three years after the completion of the Eastern Avenue bridge, to give the State a right of way over its territory, and pay the expense of bulkheads on the division line of its and the Commonwealth's flats in case the filling on its flats did not keep pace with the filling on the flats of the State.

The only coöperation the Boston Wharf Company could give the State, was by filling its own flats and building its wall upon their border on Fort Point Channel. This it was ready to do as soon as the Commonwealth was ready to occupy its own flats below, and it could have a guarantee that its land when made would be connected with the city.

This obligation is not in force now, as the Commonwealth, not then having recovered its title to the flats sold to the trustees of the Boston, Hartford and Erie Railroad Company, was not ready to entertain the proposition to engage in the work of improving this tract with its own means.

The Boston Wharf Company, however, is now energetically prosecuting the work of filling its territory. This is all that can be asked.

It is ready to bind itself to finish its work of occupation whenever the State will occupy its flats adjoining, and the municipal authorities of Boston will agree to connect, by Eastern Avenue, the land so made with the city proper.

It seemed to the Board that the most satisfactory coöperation that could be obtained from either of these companies would be in the form of a purchase of this parcel of twenty-five acres, subject to the obligation to wall in and fill up the territory according to the plan of occupation prescribed by law. A committee of the Board was accordingly appointed, that it might, after consultation with the governor, as provided in the Resolve, negotiate a sale of these flats to the Boston and Albany Railroad Company.

At such consultation the trustees of the bondholders of the Boston, Hartford and Erie Railroad Company intervened and asked for delay, inasmuch as they had but recently come into the trust they held, and wished for time to ascertain what their

position was and whether they could or should do anything to prevent this tract of flats from passing out of the control of the owners of their road. They argued that the State was a large bondholder and had a pecuniary interest in having that course pursued that was best for the road. To the force of these suggestions the Board so far yielded as to postpone further action.

Subsequently, however, the trustees of the bondholders allowed the tract of land and flats sold by the Boston Wharf Company to Messrs. Harvey, Whitney and Groves, trustees for the Boston, Hartford and Erie Railroad Company, to pass out of their control, and the Boston Wharf Company to resume its title to them by a sale under the mortgage held by trustees of the Boston Wharf Company as security for the purchase money.

This territory lay on each side of the track of the railroad, and comprised twenty-six acres of made land, some of which supplied the road with terminal facilities, and twenty-two and two-thirds acres of adjacent flats, beyond which and adjoining lie the twenty-five acres belonging to the Commonwealth.

It now seemed that if neither the land actually in use for terminal facilities, nor the adjacent tract of flats, could be held by the trustees for the benefit of the railroad, still less could they be relied upon to purchase the flats of the State which lay a thousand feet further off from their road than the parcel of flats which the Boston Wharf Company had been allowed to resume the title to.

The relation which the occupation of these twenty-five acres at the junction of Fort Point Channel and the main channel bears to the whole South Boston improvement is so important that delay in this part would tend to delay the whole. It would increase the expense of improving the adjoining portions, be injurious to the harbor, and possibly lead to embarrassing complications.

The State could not afford to hold these flats until the indefinite, however certain, period when the owners of the road would be able to purchase and improve them. When that time came, whatever land the railroad needed, the legislature would of course give it authority to take upon paying its duly assessed value. Accordingly, the Board consulted the governor again with a view to opening negotiations with the Boston and Albany Railroad Company. Acting upon his advice, however, this busi-

ness was again postponed until after the sale of these flats under the Commonwealth's mortgage, the proceedings for such sale being then pending. The sale did not take place until the 14th day of December last.

Since the sale the Board has held a conference with the Boston and Albany Railroad Company upon the subject to ascertain upon what terms it would add these flats to the purchase it has already made, and have ascertained that it is not disposed to add to its former purchase. It is ready and desirous of proceeding at once with the work of improving its own parcel, and will coöperate with the State, or whoever owns the corner lot of twenty-five acres, to the full extent, so that the work on both parcels, where desirable, may go on together. It also gives assurances that it will be a customer for a portion of this land when filled.

The trustees of the bondholders of the Hartford and Erie Railroad Company have also intervened with an application to the Board not to initiate any proceedings looking to such a disposition of these flats as would place them beyond the reach of the owners of the Boston, Hartford and Erie Railroad, and suggesting as a possible arrangement that the State should make the improvement with its own means and lease the land at a rental for the use of the road. This application is in the Appendix.

Regarding simply the interest of the State in disposing of its flats and carrying out this improvement, the most satisfactory course would be to dispose of them to a responsible party who would be bound to enclose and fill them up.

At the same time, also, it is for the interest of the State, as a bondholder of the Boston, Hartford and Erie Railroad Company, that the road should have in this locality a tract of land for terminal facilities in Boston, and it might not be disposed to part absolutely with the control of these twenty-five acres until it was certain that this road, in which it is so largely interested, had provided itself with a proper terminus.

The management of the road, being merely trustees, are not able to bind the future corporation that in about sixteen months will come into a complete title to the road, and can neither buy of the State nor the Boston Wharf Company, which also has for sale lands and flats adjoining those of the State, and furnishes the road some of its present terminal accommodations.

But it is absolutely essential to the interests of the State that the work on these twenty-five acres should be begun on some terms during the coming season. The occupation of this parcel and the guarantee of the city of Boston, that when the land is made it shall be connected with the city, are all that is needed successfully to initiate a great public improvement that will bring some seven hundred and fifty acres of State flats into the market as the growth of the city brings them into demand, and ultimately put millions of dollars into the treasury of the State.

The Board have, therefore, no hesitation in advising and urging that, if it is considered expedient to retain the control of this parcel of flats until the new Boston, Hartford and Erie Railroad Company has been established, and even without any reference to the wants of this company, if no purchaser on favorable terms can be found to make the improvement, the State should enter upon the work with its own means, certainly to the extent of building the sea-wall and doing so much of the filling on the division lines between these flats and the adjoining flats of the other owners as will obviate the necessity of building bulkheads on these lines to retain the filling. This done, all will be done that is essential for coöperation by the State with its neighbors, and the question whether it had better complete the filling itself or not can be decided hereafter.

The estimated cost within which the whole work both of filling and enclosing this parcel of flats can be done, is as follows:

The whole area,	1,178,440 square feet.
Mean depth of filling,	17 feet.
Amount of filling,	741,987 cubic yards.

Cost of 741,987 cubic yards at $62\frac{1}{2}$ cents,	\$463,741 87
of heavy sea-wall, 1,230 ft. at \$189 per ft.,	232,470 00
of light wall, 700 ft., at \$33 per ft.,	23,100 00

Total cost,	\$719,311 87
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Cost of filling per square foot of surface area,	$39\frac{1}{2}$ cents.
of walls " " " " "	$21\frac{1}{2}$ "

61 cents.

No one can doubt for a moment that the occupation of this territory, at a cost of sixty-one cents per square foot, is an absolutely safe transaction.

In view of the uses to which the Boston, Hartford and Erie and the Boston and Albany Railroad Companies will put the new land to be made in this locality, and of the fact that it will be within nine hundred feet of land on Broad Street that is now assessed at five dollars per foot, no one can doubt that the transaction would be a highly profitable one to the State.

SEA-WALL.

This Board was also directed by chapter 91 of the Resolves of 1871 to inquire into the expediency of authorizing or requiring a temporary bulkhead to be built, instead of a sea-wall, on or near the exterior line, so called, of the South Boston flats.

The exterior line referred to is the exterior line fixed by the United States Commissioners on Boston Harbor,—Rear-Admiral C. H. Davis, then Chief of the United States Naval Bureau of Navigation, General J. G. Totten, Chief of United States Engineers and Professor A. D. Bache, Superintendent of United States Coast Survey, who defined the limits of admissible occupation and the conditions on which the plan of occupation could be executed.

The authors of this plan of improvement were eminent hydrographical and constructive engineers, who were engaged six years in studies of Boston Harbor, which guided them in determining this exterior line of occupation. It was established as a permanent limit of structures on that side of Boston Harbor.

In this view the Board has been unable to see the expediency, on this line, of a temporary structure.

This bulkhead must be so built as to serve as a retaining wall to grade 16 on the margin of the main channel, where the water will be twenty-three feet deep at mean low tide. No ordinary bulkhead of piles and sheathing could withstand such a pressure of the material behind it without such a substantial backing that the bulkhead would form an insignificant part of the cost of the structure.

The bulkhead must have the strength of a permanent structure, while in fact only a temporary one. This would be poor economy and could not favorably affect the market value of the

land if so enclosed. The fact that there is no land in Boston Harbor on deep water enclosed otherwise than by substantial sea-walls, and that of the many eminent engineers who have considered the means to be used for retaining the filling on the margin of the main channel, none have recommended anything but a massive wall, is conclusive evidence to the Board that this is the only kind of structure to be thought of. Mr. George Baldwin, who, in 1867, was specially appointed by the governor and council to devise the kind of retaining wall for the South Boston flats, recommended a heavy sea-wall for this exterior line, and one of a lighter character, if built eight hundred feet within that line.

In 1868 the Board submitted the question of the kind of wall to be built on this outer line to a board of engineers, consisting of the engineer of the Board, Mr. A. Boschke, Mr. T. Willis Pratt, Mr. George Baldwin, Gen. J. G. Foster, of the United States Engineers, and Mr. James B. Francis, who devised the heavy sea-wall shown on the plan in the appendix, as the best and cheapest admissible in this location, and it was adopted by the Board.

The light wall for seven hundred feet of the line of the State flats on Fort Point Channel costing only \$33 a running foot, is the same in character that the Boston Wharf Company has considered it economical to build further up the stream, and is to build on its flats still unfilled on this channel.

The residue of the wall around the State flats as far as to those of the Boston and Albany Railroad Company, will be at the outlet of Fort Point Channel, where it joins the main channel by a curve downward, so that when the waters of the two channels unite they will be going in the same direction. This corner and curve is a critical point and must be guarded by a substantial structure.

The expense of such a structure undoubtedly bears heavily on this particular lot, but then it is by its location one of the most valuable portions of the whole tract, and likely early to be demanded as the site of warehouses and business that would require a heavy retaining wall on the water-front. But as the occupation advances down the harbor, the cost of the wall will be distributed over a large area, and one foot of wall on the exterior line will be the front for more than four thousand feet of land behind it.

Beyond this corner lot are the flats already sold to the Boston and Albany Railroad Company with the stipulation on the part of the company that it is to build on this exterior line a heavy sea-wall of the character shown on the appended plan.

Besides the saving of expense, it has been urged in favor of a bulkhead, that in case a sea-wall is built, and a dock should be wanted, the wall must be torn down and the cost of it thereby lost.

But on this corner lot of the State within the extent of the heavy wall, amounting to twelve hundred and thirty feet, a dock will probably not be found admissible, inasmuch as, being upon the bend of the channel it would tend to form injurious eddies in the stream. The United States Commissioners in their report say:—

“No slips should be allowed to approach the apex of the curve at the point of the flats within a certain fixed distance which may now be laid down as two hundred yards subject to future correction.” Measuring in both directions, this restriction would cover twelve hundred feet on this curving exterior line where there can be no dock; an extent which is within thirty feet of the whole line of heavy wall upon the flats of the State in this corner.

In any place, however, where there is any probability that a dock will be built, a space can be left in the wall to be temporarily occupied by a bulkhead, and a space behind left unoccupied by the filling.

SOUTH BAY AND FORT POINT CHANNEL.

By the Resolve chapter 91, 1871, the Board was directed to report upon the expediency of filling up South Bay and Fort Point Channel.

By a previous Act, chapter 335 of the same year, the legislature gave authority to the Board to take measures for the improvement of the navigation of South Bay by surrendering some portion of it to occupation, but at the same time deepening the reserved water-space by excavating from it the material used for such occupation. By Resolve chapter 69, the legislature directed the Board also to report upon improved means for facilitating the traffic across Fort Point Channel and Charles River. This last Resolve was the result of a very thorough investigation, and expressed the conviction of the committee that reported it, that

the draws on Fort Point Channel were not to be closed, but that improved facilities were to be secured for reducing to the lowest terms the interruption of travel by the passage of vessels.

In 1868 a very able committee, composed of members of both branches of the legislature of 1867, appointed to consider the whole subject of the occupation of the South Boston flats, urged upon the legislature the filling up of Fort Point Channel in connection with the occupation of the South Boston flats, and submitted carefully prepared plans with this view. These plans, however, contemplated the preservation of South Bay and the emptying of its waters into the harbor by a new channel along the shore of South Boston. The legislature in 1868 declined to enter upon the project, and in 1869 authorized the abolition, from the plan for the occupation of the South Boston flats, of the reserved channel along the South Boston shore which could have been made to serve as the outlet of South Bay. Since 1868 the legislature has granted licenses for the construction of six new wharves in South Bay, under which within the last three years four have already been constructed.

This Board has at many legislative hearings, and explicitly in its report to the legislature of 1869, expressed an emphatic opinion that the public interest required the waters of Fort Point Channel and South Bay to be kept open to navigation.

The evidence of this settled conviction of the legislature in favor of preserving to commerce these portions of Boston Harbor, expressed so constantly and in such a variety of forms, and its instruction to this Commission, that had already frequently asserted the same conviction, to report again to the legislature upon this subject, has occasioned the Board some embarrassment in determining whether there was any new aspect in which the legislature might desire to have this subject submitted.

The Board is not aware of any new considerations or any change of conditions less favorable to the conclusion heretofore so often reached by the legislature and by itself. It is led therefore to believe, that the object contemplated by the Resolve was to make an easily accessible record of the facts and considerations which have brought so many minds to the same conclusion upon a question which experience has shown to be so liable to become a subject of inquiry and debate.

The water-front upon Fort Point Channel and South Bay is four miles in linear extent, and on this front are 4,015,980 square feet of wharf property in actual use, to which are brought annually cargoes representing a value of over twenty million dollars. About ten thousand vessels of every variety of tonnage from nine hundred tons down, pass over these waters yearly. The wharves are in use and vessels come to them because they are considered by those who use them to be the best attainable for the uses to which they are put. The proposition, therefore, to fill up Fort Point Channel and South Bay, is a proposition to destroy to this extent, the best commercial facilities of the port of Boston. All that has made Boston a great centre of commerce is its harbor and the wharves upon its water-front. To destroy a large portion of its best wharves in use is simply to cripple by so much its capacity for that commerce which is the life of its greatness.

But no one proposes this sacrifice of commercial facilities except for a gain which is regarded as more than an equivalent for the loss. This gain is of two kinds. 1. The relief to teams and travellers from the detentions caused by the opening of draws for the passage of vessels. 2. The increase of valuable territory near the centres of business. The first is undoubtedly the consideration that has been most influential in suggesting as a remedy for the inconvenience caused by these navigable waters, the extreme but most obvious one, of abolishing them altogether. But if these waters furnish the best, or even needed facilities for the uses of the commerce of Boston to which they are put, this branch of the inquiry simply resolves itself into the question whether four miles of the most useful and valuable commercial water-front of Boston shall be forever destroyed to avoid the obstruction to teams and travellers in going to and from South Boston, in the transaction of a small portion of that vast business which the fact that Boston has a water-front is the cause of. Such a course would amount to sacrificing business to increase the facilities for doing it. Undoubtedly it is an easy way to prevent the friction of working an engine, to stop it altogether. But the motive power is lost in so doing, and it is to be remembered that it is for the motive power it represents that the engine was made. The delays of land travel caused by the passage of vessels through draws is part of the necessary

friction that arises from the compact concentration of population and business in every great commercial port. And this very concentration of population and business is caused by the fact that by such concentration, business is conducted with the least delays, and at the least expense. Even on the land at the crossing of crowded streets there is the same difficulty. There is no break in the intersecting streams of travel before reaching their intersection, but both cannot occupy at the same time the portion of the two streets that is common to them. One stream of travel must therefore necessarily wait for the other, and policemen will be found stationed at such points to equalize the concessions that these conflicting interests must make to each other. But even if all this merchandise were landed down at the outer line of the South Boston flats, when it shall become an available water-front, it must all be carted across the streets leading from South Boston, and become an element of delay in the passage of streets that is not to be left out of the account in considering the hindrances to land travel caused by the navigation of these waters. The passage of every cargo through the draws in the bridges over these waters, represents a relief to the streets of a multitude of long, heavy teams, slowly drawn. But the economical advantage of these waters to the whole community should be decisive upon the question of maintaining them. Transportation by water is the cheapest kind of transportation everywhere, and especially within the crowded borders of a great city, and the saving effected by it is a saving to the public.

The vessels, for instance, that pass into South Bay carry lumber, coal, wood, iron, brick, cement, lime, sand and other materials of great bulk in proportion to their value, that are consumed in Roxbury, the South End, and the contiguous neighborhood. In the distribution of these cargoes from wharves on South Bay it is estimated that at least a hundred dollars on every cargo is now saved to the community which would be lost in the increased cost of transportation were South Bay closed to navigation. Such a saving on the two thousand cargoes and more a year that are water-borne to South Bay, amounts annually to over \$200,000, or an investment for the public benefit of over four million dollars, to say nothing of the saving to the streets by relieving them to such an extent from the cartage of these heavy materials. And this benefit is an increasing one. Since

1860, the annual passages of vessels through the Dover Street draw in going to and from South Bay have increased from 2,566 to 6,564. This saving by water transportation in the vessel in which the cargo is brought into port, can be effected in no other way. Railroad transportation would be an impossible substitute, and if not so, would be open to the insuperable economical objection that it would involve an additional handling of all the freight, an additional loading and unloading of every cargo.

The waters of South Bay and the upper reaches of Fort Point Channel, so far from being regarded as evils, should be regarded as benefits. The city of Boston, and its southern suburbs are the better organized for business, growth and maintenance, by reason of these waters, and would be even better off, if these waters extended still farther inland.

It is often said, How can there be need of wharves on South Bay when the wharves at the North End, on the deep water of the harbor, are such poor property? The fact that new wharves are built on South Bay, and are not built at the North End, and that when built they are worth more in the market, would certainly prove that they are needed, and supply a want in the community; and the reason of this is obvious. When Boston was first settled, the end of the peninsula where it came nearest to the vessels bringing commerce to the port was naturally the seat of business and population. But as business has increased, it has been continually driven to get room farther up from the extreme water-front of the city.

In this way the business centre and the centre of population have gradually moved up town.

All the materials used in building up the city around new centres, and providing dwellings, and many kinds of merchandise for an increasing population, are landed nearer their places of destination from Fort Point Channel and South Bay than from the older wharves at North End, although on deeper waters of the harbor.

A similar process has gone on upon a larger scale in the city of New York. Business and population have moved up town. The new wharves are built on East and North Rivers, and are more crowded with ships having cargoes of merchandise than those at the Battery. The judgment of intelligent and enterprising communities, the world over, as shown by their action,

is against the expediency of destroying waters that sustain such relations to commercial cities as South Bay and Fort Point Channel. Chicago has the Chicago River running through the most populous parts of the city; twenty-seven streets cross this river, and every one of them, not having a tunnel, has a draw. It is true that from the absence of any secure roadstead upon the lake the river serves as a substitute for a harbor. But only a portion of the river is needed for harbor purposes, and the maintenance of draws in all the bridges beyond what is required for harborage, notwithstanding the obstruction to travel caused by these draws in the heart of the city, is justified only by the saving in transportation effected by having merchandise brought by water so much nearer to the points of its destination. On two of the streets this obstruction has been wholly obviated, not however by closing the draws, but substituting for bridges, tunnels at a cost for each of from four to five hundred thousand dollars. Such is the testimony that energetic Chicago with its robust enterprise brings to the question of shutting out navigation from the rear of cities to obviate the obstruction that vessels cause to the land transit of navigable channels. The example of many European cities could be cited to the same effect. To secure even in a much inferior degree such access by water as Fort Point Channel and South Bay supply to the adjacent territory, inlets from the general line of the water-front are at immense expense actually excavated from the virgin soil.

The legal difficulties in the way of such a project are enough of themselves to make it inexpedient. It would have to be carried out without the coöperation of the wharf owners, and against the determined opposition of most of them.

They hold, by grant of the State, rights of wharfage and dockage appurtenant to their estates. These would have to be appropriated by the right of eminent domain, and a compensation paid, to be assessed against the State or municipality making the appropriation. Owners of property are rarely if ever willing, in view of possible, or even probable advantage that may ultimately result to them from the conversion of a wharf property to a building lot, to forego their claim for the immediate damage to them caused by the appropriation of their rights for the public use.

Then, too, the destruction of every wharf involves the breaking up of the business of every tenant to whose business a wharf is an indispensable adjunct. Here would be an element of injury of an incalculable extent. And after all this expenditure, and uprooting of business and establishments that have been the growth of years, the only result is a dead loss to the city and its neighborhood, of natural advantages. A great expenditure will have been made to destroy what intelligent and enterprising communities often expend more to save or create.

But it is sometimes urged, in favor of filling up South Bay, that Boston needs more land. The statement is undoubtedly true that Boston does need more land, but this is far from proving that to get it, much of her most useful water-front is to be destroyed. Boston, municipally speaking, has needed more land, that its government and its great business interests may be in the same hands. This has been secured by annexation. If it is said that Boston needs more land for its population, there are ample unoccupied spaces in her borders that have not yet been built upon, and she has the open country all around her, with quick access by railroads.

South Bay has, however, been specially designated as the place in Boston for cheap land for houses for the poor, why, rather than the upland beyond it which it has cost nothing to make, it is difficult to see. Of course the authors of this suggestion intend the land made from this bay shall be healthful for residence. The most expensive land for the poor man is that which would imperil all the capital he has in the world—his health. The land must be assumed to be properly drained, made with suitable filling, carried to a proper grade. Now if such made land should prove to be cheap land, the making of it would not be likely to be financially profitable. If it should command a high price, this would place it beyond the reach of the poor, and frustrate the benevolent object for which the bay would be surrendered. Doubtless some means should be provided by which the multitudes who work in great cities for wages should be provided with healthful homes, on good land, at rates they can afford. But relief must come by cheap transportation over those very railroads that are the cause, in recent times, of the unexampled concentration of business and population in cities. The filling up of South Bay will contribute nothing to the solution of the difficulty.

But Boston, it is said, wants more land for business purposes. This is undoubtedly true. But where does she want this land? She wants more land that has those natural advantages for business which her situation on the deep waters of Boston Harbor originally gave her, and which have made her what she is. She wants more land near the business centres of the city, that has the advantage of being near the water-front.

Now to destroy South Bay by filling it up, is simply to diminish the amount of land in Boston that has this convenient access to a water-front which business demands. And it seems to be conceded by those who advocate the filling of South Bay, for the sake of obtaining cheap house lots, that it is not the facilities for business that this measure would be expected especially to promote.

A very fallacious argument used in advocating an increase of territory by filling up tide land on the city water-front, is this: It is assumed that there is always just so much clear gain of land near the water-front. On the contrary, there may be no gain whatever, and the only result may be that all the rest of the territory of the city is thereby thrown further back from this front. If an addition to the city is made by extending it out into the harbor, the addition throws all the rest of the city by so much inland, and other things being equal, it would be better that an inland addition of occupied territory should have been made, without the cost of filling, and without disturbing the existing relations of the whole city to the deep-water frontage. For those who owned the harbor bottom at this particular point, if near the centre of business, the extension would yield a profit, but to the community a loss, assuming, of course, the question to be merely whether it is better for the public that an increase of occupied territory be made on the water-front, or on upland in the rear of the city.

By filling up South Bay, all the unoccupied natural upland to the south and west is carried so much further from the water-front. Those who own the bottom make money by the operation, but those who have unoccupied land beyond lose the demand for their upland, which would have existed but for the filling of the bay. The public lose on the transportation of merchandise, and by the waste of labor in making land where there was natural land, which it cost nothing to make, available.

Equally fallacious is the argument in favor of making land of the beds of these navigable waters, which computes the value of the land so made at the price of the occupied land around it, and then assumes that the aggregate value of this land for occupation must be just so much added to the wealth of the city.

But the demand that would cause this made land to be occupied will cause just as much natural upland adjacent to be occupied in the same way, and with a saving of the cost of filling; and if, by making this land, needed commercial facilities are destroyed, the aggregate value of Boston, as a commercial city, is reduced. She declines, too, in the relative valuation of the cities of the United States.

The question of filling tide lands, that would be occupied, if filled, is a question between the owners of those lands, and the owners of the adjoining upland and the public. If it is best for the public, all things considered, that the tide lands should be filled, let the owners of them make the profit, and the owners of the adjoining upland lose the chance of making the profit they would have made had their lands supplied the demand; if it is not best for the public that these tide lands be occupied, let the occupation take place on the adjoining upland. It can, however, never be otherwise than at a loss to the public that tide land is filled at a sacrifice of needed commercial facilities. For the destruction of these, is the destruction of the sources of wealth.

The navigable avenues in and about Boston, and tributary to Boston Harbor, cannot fail to play an important part in developing this growing centre of business and population. Every portion of the undeveloped territory in its neighborhood, that possesses the economical advantage of accessibility by navigable waters, will be required to meet the demands of this expansive and multiform energy of growth that is here concentrated. If all such waters are not absolutely needed now, they should be spared for future use. These natural features of the shore, that give it great capabilities, and which, once destroyed, can never be recovered, the State, which exists for all time, holds as a sacred trust, not merely for present use, but to transmit, as nearly as may be, unimpaired, to its people in future generations. The policy of the Commonwealth, in regard to her navigable

waters, is in harmony with this trust. She would use them, utilize them, and for the purpose of utilizing, consent to the occupation of the tide lands bordering upon them, but always upon such terms and conditions as will insure their preservation, and, when possible, their improvement.

This Board was established to preserve such waters from unauthorized encroachment and injury. That the structures in and over tide waters authorized by the legislature, may be so built as to do the least injury to harbors and navigable channels, the plans for their construction must be approved by this Board.

The eminent engineers constituting the United States Commission, and acting in behalf of the city of Boston, after careful investigation and surveys, ascertained and stated in their reports to the city, that the encroachments upon its harbor, and the consequent reduction of its volume of tide-water, had so reduced its scouring force that the effects of its loss were shown in increasing deposits upon the harbor bottom, and they advised that no further encroachments should be permitted without compensation for the injury. The State promptly passed the law requiring for every structure that diminished the tidal reservoir of Boston Harbor, compensation, either in an equivalent increase of such reservoir in some other part of the harbor, or a payment into the State treasury, for the benefit of the harbor, of a sum of money sufficient to defray the expense of such an increase of reservoir, or some equivalent harbor improvement.

The Harbor Commissioners are also charged with the development of the property of the State, in tide lands, but the Commonwealth in the Resolve first committing the improvement of its great domain in the South Boston flats (ch. 81, 1866) to their charge, gave them this injunction: "the said Commissioners in all plans and proposals submitted by them, always regarding the *protection and improvement of the harbor of Boston as of paramount importance*, in any intended occupation of said flats." The reports of the United States Commissioners upon Boston Harbor, whose constant teaching is the subordination of all schemes of encroachment upon the harbor to the paramount public interest of preserving it, are recognized in the Act establishing this Commission (sect. 8, ch. 149, st. 1866), and the Resolve already cited, as the authentic guide of its action.

There is, in fact, no better illustration of the principles upon which the Commonwealth deals with navigable waters and the tide lands bordering upon them, than the Act passed by the legislature of 1871, which directed this inquiry, and entitled "An Act for the improvement of navigation in South Bay and the modification of its harbor lines."

Authority is there given to fill up portions of the bay, provided the material for such filling is taken from the water area still to be reserved. The filling of tide lands is here permitted, but upon terms that secure for the tide-water displaced from the filled portions an equivalent in the partial restitution of the tidal volume and the improved navigation that results from the deepening of the bay. Until tide lands become of such value that their owners can afford to occupy them upon such principles, it is not for the public interest that they be occupied. The injury to the harbor is greater than the gain afforded by the increase of territory.

We have made no objection to this project of filling up South Bay and Fort Point Channel on the ground of their physical relation to Boston Harbor, for the reason that this relation is not so important that it should control the decision of the question. The investigations of the United States Commissioners, proved that South Bay in the present encumbered condition of its outlets, was not a tidal reservoir of any efficacy to the upper harbor. The contribution that the lower portion of Fort Point Channel makes to both the upper and lower harbors, and that South Bay makes to the lower harbor, although of value, is so small compared with the immense volume of tide-water accumulated below the outlet of Fort Point Channel from all other sources combined, that the application of the general law of the Commonwealth that requires compensation for the tide-water permanently displaced from Boston Harbor, would obviate the physical objections to the measure. The effect upon Boston Harbor is an element in the question only as the compensation for displaced tide-water would increase the cost of the undertaking. To this slight extent, however, it certainly would interfere with the philanthropic purpose of those who would incur the great expense of filling up this bay, to secure in so central a location cheap house lots for the poor.

If the views that have thus far been advanced are correct, it would seem that the practical judgment upon this subject, of the business community that would be affected by the destruction of these waters, would be shown by unmistakable acts. Such has been the case. Within three years, four wharves have been built on the north-west side of South Bay that are now worth over four hundred thousand dollars, and the flats there have risen from thirty cents to a dollar a square foot. The city of Boston has built over Fort Point Channel the most expensive iron bridge in New England, upon the assumption and belief that the waters of South Bay and Fort Point Channel were permanent features in the configuration of the city.

Upon South Bay there are iron works in which half a million dollars or more of capital is invested ; there will soon be an equal investment here in a lumber and manufacturing establishment, now nearly completed.

Last winter the legislature made this same subject, only in the form of a proposal for closing the draws on Fort Point Channel a matter of inquiry before two of its committees,—the Committee on Federal Relations and the Committee on Harbors. The Old Colony & Newport Railway Company, the Boston & Albany Railroad Company and a multitude of wharf owners and business men, all represented by counsel, appeared and earnestly resisted the proposition, and no one appeared who would take upon himself the responsibility of really advocating the measure.

There are a few persons, undoubtedly, mostly owners of South Boston flats, who would be willing to see the bay and its outlet filled up for the increased value that would be given to their land, by having in this way a connection with Boston proper by land instead of by bridges, and there have been those who, in view of the increased value that could be given to the State flats in South Boston, by such solid, unbroken connection, have, in the supposed interest of the Commonwealth, advocated these changes.

But if, as has been shown, these waters are of general advantage to the great community who use them, or receive indirectly the benefit of their use, it would be a great abuse of power on the part of the State to sacrifice these public benefits

merely to enhance the value of its own or another's adjacent real estate.

Plans have also been advocated for maintaining South Bay and giving to it a different outlet, either across the South Boston flats, coming out just below Slate Ledge or extending along the hundred-rod line of littoral proprietorship to the main channel. An outlet even by way of Dorchester Bay has also been advocated.

The economical objection to all these projects is, that they contemplate the substitution of an artificial, unoccupied navigable channel for a natural and occupied one. To control the direction of the flow of these waters on leaving South Bay in a new path, the new channel must be substantially walled in on each side. Taking the shortest admissible course to the main channel, this would require, for both sides of the water-way, a wall over a mile and a half in length, built up to grade sixteen, through a tract of unfilled flats and the wall must be protected with a substantial backing of material that would not yield to the action of the water. This new channel would have to be dredged out to twelve feet below mean low-water throughout its length, or the bottom to that depth would be washed into the harbor and greatly injure it.

Should the new channel not be built until after the land has been filled, then the filled land must be idle until the whole filling is completed and a loss of income on the invested capital sustained, unless the expense is incurred of building temporary bridges over Fort Point Channel, to remain until the new channel is opened and the old one closed. After all this expense, what is the result? The Dover Street Bridge, the Broadway Bridge and the Federal Street Bridge remain. Only the necessity for an extension of the proposed eastern and northern avenues by bridges or tunnels across the line of Fort Point Channel would be removed. The Washington Avenue Bridge over Fort Point Channel would be removed, but a new one in its place would be required over the new channel near the line of Granite Street. The newly made land that would be connected by solid ground with Boston proper, would require at every principal street, bridges over the new channel to connect it with South Boston.

The difficulty, therefore, is not removed, only the form of it is changed. Should a longer channel nearer the shore of South Boston be made, it would be so much the more expensive, and no access to it could be obtained from this shore until the territory between the shore and the new channel had been filled to a grade with its inner retaining wall.

We need make no objection to this scheme on the ground of the disturbance of business and the destruction of the valuable wharves on the lower part of Fort Point Channel before a new water-front is made to supply its place, for the reason that it would be possible to leave all the channel below the line of Eastern Avenue undisturbed, to serve as a great dock and be gradually filled up as business could adjust itself to the change. Still, the new water-front that could be obtained would not be so sheltered as that on the western side of Fort Point Channel, or so accessible to the business centres, and the new narrow channel, because longer, would be more inconvenient than the present one for vessels passing up into South Bay. But with this concession, more than likely a million dollars must be expended to build the new channel and bridges.

Some three hundred acres of the State flats would be enhanced in value; but how much more would they be enhanced in value by being connected with Boston proper through the filling up of Fort Point Channel, than by a tunnel under the channel, which could be built at even less than the cost involved in the construction and bridging of a new outlet for South Bay? Besides, a tunnel connection of the South Boston flats with Boston proper, would annex the whole tract of the State, amounting to some eight hundred acres instead of some three hundred acres, including the bed of Fort Point Channel that would be annexed according to the plan of constructing a new outlet, terminating at the main channel a little below Slate Ledge, the best point for the harbor. It is not believed that the additional value that would be given to the State lands by the filling up of Fort Point Channel over that which would be given them by a tunnel, would be sufficient to justify the transfer of the immense business now done at the wharves on the present water-front to an inferior site, and increasing the distance that must be passed over in a narrow channel by all vessels going up South Bay.

The maintenance of South Bay by an outlet to Dorchester Bay, is still less to be entertained. To secure such an outlet would require the construction of a canal through about half a mile of upland, and a mile and five-eighths of flats, walled in, and on the flats backed with material that would resist the action of the water. Four miles of wall must be built to grade sixteen to construct the canal. It must also be dredged out to the proper depth, and bridged at the street crossings. To this must be added the insuperable objection that the exposure of this outlet to the direct action of north-easterly storms, would cause it continually to fill up, so as to require a constant expense for dredging it out.

The conclusion of the Board, therefore, upon this subject is that South Bay and Fort Point Channel should be maintained, and if modified to meet the demands of business or other exigencies, such modifications should be made upon the principles already indicated. In coming to this conclusion, the Board has no disposition to depreciate the inconvenience to which passengers and teams are subjected in going to and coming from South Boston. The statistics collected by the Committee on Harbors, and reported to the legislature of 1871 (Sen. Doc. 193), show the passing over the Fort Point Channel and Charles River bridges, to be as follows :—

Passage over Highway Bridges across Fort Point Channel and Charles River.

Number.	NAMES OF BRIDGES.	NUMBER OF			
		Foot Passengers.	Teams.	Horse Cars.	Passengers in Horse Cars.
FORT POINT CHANNEL.					
1	Mt. Washington Av. (1869, 24 hours, estimated), . . .	8,400	5,860	-	-
2	Federal St. (1870, 24 hours, re- corded),	17,873	5,860	763	13,000*
3	Dover St. (1870, 24 hours, re- corded),	11,932	4,119	-	-
	Total,	38,205	15,839	763	13,000
CHARLES RIVER.					
1	Charles River (1871, Jan. 11, from 6 o'cl'k, A. M., to 6, P. M.),	4,387	1,581	} 1,500*	20,000*
2	Warren (1871, Jan. 11, from 6 o'clock, A. M., to 6, P. M.) .	9,320	3,179		
3	Cragie's (1871, Jan. 11, from 6 o'clock, A. M., to 6, P. M.), .	3,906	3,249		
4	West Boston (1871, Jan. 11, from 6 o'cl'k, A. M., to 6, P. M.),	2,484	1,565		
	Total,	19,097	8,574	1,500	20,000

* Estimated.

That this flow of travel is now obstructed far beyond what the necessity of the case requires, is shown by the following tables, giving the delays at the various highway draws on both sides of the city, and the elements of that delay, and the number of passages through these draws in the year 1871. The time taken by vessels to pass railroad draws is also stated in the same table.

Table of Delays at Drawbridges on Fort Point Channel and Charles River.

No.	NAMES OF BRIDGES.				Opening.	Closing.	Vessel to Pass.	Total Time, minutes.
FORT POINT CHANNEL (Highways).								
1	Dover Street,	.	.	.	1 min. 30 sec.	1 min. 30 sec.	5 to 6 min.	Average, 10
2	Broadway,	.	.	.	3 "	3 "	5 minutes.	" 10
3	Federal Street,	.	.	.	1 "	1 "	3 "	" 5
4	Mt. Washington Avenue,	.	.	.	2 "	2 "	4 "	" 7
FORT POINT CHANNEL (Railroads).								
1	Old Colony and Newport,	.	.	.	5 min.	3 min.	5 to 10 min.	Average, 15
2	Boston, Hartford and Erie,	.	.	.	3 "	3 "	8 minutes.	" 15
CHARLES RIVER (Highways).								
1	Charles River,	.	.	.	54 sec.	45 sec.	3 min. 30 sec.	Average, 5
2	Warren,	.	.	.	45 "	45 "	3 " 30 "	" 5
3	Cragie's,	.	.	.	10 min.	3 min.	5 to 15 min.	" 20
4	West Boston,	.	.	.	3 " 30 "	3 " 30 "	8 minutes.	" 15
CHARLES RIVER (Railroads).								
1	Fitchburg,	.	.	.	45 sec.	45 sec.	5 to 10 min.	Average, 10
2	Boston and Maine,	.	.	.	3 min.	2 min.	5 to 10 "	" 15
3	Eastern,	.	.	.	50 "	1 "	5 to 10 "	" 15
4	Boston and Lowell (passenger),	.	.	.	50 "	1 "	5 to 10 "	" 15
5	Boston and Lowell (freight),	.	.	.	2 "	3 "	5 to 15 "	" 20

Table of Vessels passing Drawbridges in Fort Point Channel and Charles River for the year 1871.

No.	NAMES OF BRIDGES.	No. of Vessels.
FORT POINT CHANNEL.		
1	Dover Street,	6,564
2	Broadway (open but a few months),	—
3	Federal Street,	10,851
4	Mt. Washington Avenue,	11,363
CHARLES RIVER.		
1	Charles River,	9,228
2	Warren,	7,123
3	Cragie's,	3,552
4	West Boston,	1,574

BY WHAT MEANS CAN THESE DETENTIONS BE REDUCED ?

Relief of traffic over Fort Point Channel and Charles River.

The legislature of 1871 having come to the conclusion that South Bay, Fort Point Channel and Charles River ought not to be closed to the vessels that now pass over them,—still more, we infer, that none of them should be filled up,—instructed this Board to consider “what relief can be provided for the traffic across Charles River and Fort Point Channel, by a system of improved bridges, the use of steam in moving vessels and draws, or by any other means; and report to the next general court with plans and estimates.”

This relief may be obtained, *first*, by improved draws; *second*, improved power in moving them; *third*, improved power in moving the vessels; *fourth*, tunnels which give entire relief from all obstruction whatever.

Draws and Tunnels of Chicago.

The city of Chicago was known to have solved, in its most difficult form, the problem of reducing to the lowest terms the obstruction that navigation and land travel are to each other in cities where streets cross navigated streams.

It was thought expedient, therefore, that a committee of the Board, consisting of Messrs. Lincoln and Grammer, with its en-

gineer, Prof. Whiting, and Mr. Clemens Herschel of Boston, an accomplished constructive engineer who had made considerable study of tunnels, should visit Chicago and get the benefit of the experience of that city in this class of public works.

The great fire left the tunnels intact and most of the bridges. The visit was delayed by it a good deal, but not prevented, and was the means of getting much valuable information.

Chicago River and the water-ways surrounding the upper portion of the peninsula of Boston have many points of similarity in their geographical and commercial relations to the two cities. Each water-way passes through valuable territory thickly built upon, and the conflict of interests between the advantage of these water-ways to commerce, and their disadvantage in interrupting land transit or confining it to bridges and tunnels, involves the same general points and difficulties.

Such differences as exist are in favor of the water-ways of Boston as being the larger, deeper, and better adapted to navigation. But the difficulties of land and water transit have been better met, and in a greater degree overcome, in Chicago than in Boston.

This has been done in Chicago by the construction of two tunnels in the alignment of two of the main streets of the city, and by twenty-seven drawbridges of a plan and a working power superior to those of Boston.

In looking at the characteristics of the two harbors of Boston and Chicago, the greatly superior advantages of Boston Harbor are apparent. Even in the inner harbor and at the immediate city front, the large and protected anchorage basin is a feature wanting in Chicago.

Government, however, is building extensive breakwaters in the lake, and large anchorage basins are projected along the city front. But the city does not intend, when these are finished, to close the draws in her bridges. On the contrary, it regards the river as a passage-way for the transportation of certain water-borne materials to the rear sections of the city, essential to its growth and prosperity. Municipal regulations prescribe a fire limit for lumber yards and prohibit the occupation of ground for this purpose along the city front. In fact, the result of inquiry and observation has proved the maintenance of the navigation of Chicago River, throughout the length and

breadth of the city, the established policy and purpose of its people.

The characteristics of the drawbridges in Chicago consist mainly in lightness and narrowness, affording easy and rapid motion. All the streets which cross the river are contracted at the bridges to two single pathways. In cases where horse-car railways cross the bridges, it is through the same passage-way used by wagons, the sidewalks being constructed outside of the trusses of the bridge. The width of the wagon and horse-car ways ranges from nineteen to twenty-two feet. Such a draw-bridge requires but a small pier and a turn-table which admits of rapid motion. The plan of the later and most approved bridges is an arched truss with iron arc and chords and wooden braces, the latter material being preferred on account of the ease and economy in repairing. These draws are of liberal length and adapted to the particular locality of the bridge. Where the river bends or the approach to the draw is inconvenient, a greater width of passage-way is given, so that vessels can be towed through the openings without danger from striking on either side.

The range in width of the draw openings through the twenty-seven bridges which have been built is from fifty-two to eighty feet in the clear, these being the minimum and maximum widths. The drawbridges are all on centre pivots and turn end for end, although in some cases only one opening is available for vessels to pass.

In working these draws, great promptness and activity are shown. At the signal from a tug to open the draw, a bell is rung on the bridge, which is the signal for teams and passengers on the street to halt. The tug and vessel in tow seldom stop their headway, but often follow the draw as it revolves, and the draw in turn follows the tug and vessel as the opposite end swings to its rest, the draw thus making one-half of a complete revolution. From one to two minutes is the general range of time for opening and closing the various drawbridges, including the passage of the tug and vessel in her tow.

Instead of the rule in practice with our railroad bridges here, of stopping all water transportation for fifteen minutes before the time at which trains are *due*, no railroad train or land transit is allowed to interrupt the water transportation in Chicago

River longer than ten minutes at one time, and no drawbridge is prevented from opening by a railroad train unless it is in sight or its near approach signalized. No vessel navigates the waters of Chicago River without the use of a steam-tug. It would be impracticable to do so with the crowd of vessels that occupy the river, and without a tug it would be impossible for vessels to pass through the bridges with the rapidity and precision which are now attained. The plans and papers relating to the bridges having been destroyed by the fire, only general statements can be made concerning them. With pile and wooden centre pier and abutments, they have cost in average amount about \$30,000; those with stone centre piers and stone abutments, including tender's house, &c., about \$50,000. There were, before the fire, twenty-seven bridges crossing the main river and its north and south branches. In the denser portions of the city every street had its bridge, and the streets were from 400 to 500 feet apart. Of these bridges, eight were destroyed by the fire.

The weight of the better class of bridge draws (that of Clark Street in particular) is estimated at about seventy-five tons.

In most cases the width of the river allows the bridge draw to reach entirely across it, or if not, but slightly projecting abutments from the shores are required, so that most of the bridges now remaining on the two branches of the river are all draws with no bridge structures save the solid abutments on either side.

The bridges, however, over the main river were longer, but had all been destroyed.

The bridge draws, although of good model, and well worked and managed, are not the best specimens of workmanship. The centre piers and abutments are made of pile and wood-work, and would not answer a similar purpose in Charles River or Fort Point Channel; even the stone piers and stone abutments are not such as our deeper waters and rapid tidal currents would require.

The water-ways to be crossed in Boston Harbor would also require a greater extent of bridge structure on either side of the draw-ways, with additional piers besides those required for the centre and abutments of the draws, and all of these would need to be higher and stronger than the Chicago piers. The ground bordering the respective localities is quite different in character. In Chicago, the upland of the prairie forms the river bank, while

in Boston the solid land is quite in the rear of the channel, so that a number of substantial piers would be necessary in the latter case in addition to the river piers.

These differences would make a similar kind of bridge more expensive in Boston than in Chicago.

The tunnels of Chicago have successfully solved the problem of the conflicting interests of land and water transit, and are without objection in the estimation of the people.

The roadways through the Washington and La Salle Street tunnels are as favorable to city transit, except in the slight grade which they present, as any part of the respective streets. They are dry, well ventilated, and can be well lighted. The passenger way is a sheltered, dry and cheerful walk, far pleasanter to pass over in bad weather than a bridge. In the present condition of Chicago these tunnels are thronged with teams and foot passengers, and just after the fire, afforded the only means of crossing the river in the burnt district of the city.

The cost of contractor's work in constructing the Washington Street tunnel was \$395,664. The cost of such work on the La Salle Street tunnel was \$461,093. The time taken for the construction of the Washington Street tunnel was eleven months, for the La Salle Street tunnel twenty months. The length of the Washington Street tunnel, from the ends of the uncovered way on each side of the river, is 1,525 feet; the length of uncovered roadway on the west side 320 feet, and on the east side 272 feet. The length of the covered roadway 933 feet. The length of way for foot passengers between the two entrance houses 811 feet. The width of single roadway through the uncovered sections and single arch is 20 feet; the width of the divided double roadway under the river section 11 feet for each roadway. The height of the single arch over the road bed 15 feet, the height of arches over the double roadway 13 feet each. The width of the passenger way is ten feet, and the height of the arch 8 feet. The grade of the roadway of this tunnel is not equal on the two sides,—the grade on the east side being one in 16, or 6.66 to 100, or about 330 feet to one mile; on the west side 1 in 18.626, or 5.4 to 100, or about 283 feet to one mile. The depth of water in the channel at the La Salle Street tunnel is 18 feet, at the Washington Street tunnel 16 feet, at low water of the lake,—the fluctuation in the height of the lake level being

about two feet. The La Salle Street tunnel was of less grade, and consequently somewhat longer. Both were built by means of coffer-dams and without obstructing navigation.

Improvements in Drawbridges.

In determining the best plan for drawway openings and drawbridges for Charles River and Fort Point Channel, many conflicting considerations must be adjusted; the main object in view being to provide such structures and determine such modes of operating them as shall offer the least obstruction and delay to both the water and land transit. As the passage of vessels through the bridges is a primary condition of the case, a drawway opening which shall most facilitate their passage through it is a first consideration. This should be of such a width as to allow a tug and vessel to pass through without checking their general speed, and without the liability of striking against the sides of the passage-way. Where the depth of the channel is not much more than the draught of the vessel, so that she would otherwise nearly fill up the passage-way, some space should be allowed on either side of her for the relief of water flowage, particularly where strong currents are to be met. Spaces of five or six feet between each side of the vessel and the sides of the passage-way are not undue allowances.

As regards width of water-way, if the waters of Fort Point Channel and Charles River above the first bridge are to be used by vessels no larger than those which now use them, or are likely to use them while as obstructed as they now are by bridges, a width of 44 feet, which the legislature of 1869 prescribed for the draws in the Charles River bridges, would perhaps be sufficient for all the draws except that in the bridge between Charlestown and Boston, which should have a width of at least 60 feet, in consideration of the extensive basin there will be between the Fitchburg Railroad bridge and the bridge which it is proposed shall be substituted in place of the Charles River and Warren bridges.

In the construction and dimensions of the drawbridge, the main points to be considered are its capacity as a good roadway and the rapidity with which it can be opened and closed.

Lightness of structure is a main element in all that affects the movements and adjustments of a draw, and this is immediately

dependent upon its size. Here the question arises as to the best width of roadway in relation to the pressure of travel and its interruption by the open draw. As the drawway opening should be reduced to the least width advantageous to the passage of the vessel, so should the roadway be reduced to a width which shall make the structure as light as possible, while it gives proper relief to its interrupted travel. In Chicago this adjustment has been found in a narrow bridge-draw. Her experience, and the testimony of her experts upon this point, are all on this side of the question. The city engineer, Mr. E. S. Chesbrough, and the members of the Board of Public Works of Chicago, even went so far as to urge our Board to give this style of draw a trial, asserting that we would never return to the wide, heavy and cumbersome draws we now have in use. A greater economy in weight can be effected by narrowing than by shortening a draw in equal extent. In a pivot draw forty feet wide, and spanning double openings of forty-four feet wide, an equal contraction in width or length would be as 132 to 40. In Chicago, none of the drawbridges have more than two passage-ways, one for each direction of travel. Where lines of city horse cars occupy the streets and cross the draws, the same passage-way is used by other vehicles. It should be borne in mind, however, that in Chicago they have twenty-seven bridges and tunnels to divide and distribute the city travel, while in Boston it is more concentrated at given points, as the Charlestown, Cambridge and South Boston bridges; so that for Boston it may be wise to provide a wider drawbridge than those used in Chicago; but to double their width, and allow two passage-ways for each line of travel, and these the minimum width admissible for horse cars and common wagons, would seem to be sufficient on bridges of ordinary width. The sidewalks for foot passengers should be built outside of the main trusses of the bridge, and be made of lighter structure.

We are aware that narrow drawways are not now in use in Boston, and that the general opinion is that the draw must be as wide as the main bridge or street, and we presume that a sudden material contraction of an avenue at the draw would seem to many an objectionable proposition. We think, however, that the weight of argument is in its favor. It is only by this device, accompanied by the use of the steam-tug, that the

whole obstruction to travel, caused by the passage of a vessel through a draw, is reduced in Chicago to the minimum of half a minute and the maximum of two minutes. The most thronged avenues that cross the river in the heart of that great city, some of them 100 feet wide, are contracted at the drawbridges to a width of but 19 to 22 feet, and these are so light and well adjusted that their rapid movement is attained by the hand-power of a single man.

Looking to the material point of ease and rapidity of movement, the centre-pivot draw is found to be the best model. This is the kind universally used in Chicago and throughout all the West, where the building of drawbridges has been a subject of great study, and been brought to a high degree of perfection. It should be so constructed, also, that the draw may make half a revolution every time it is opened for the passage of a vessel. In this way there need be no cessation in the turning of the draw, as the process of closing can be begun as soon as it is completely opened, as the vessel will by this time have passed full half through the drawway, if going at a reasonable rate of speed. If the draw is turned but a quarter of the way around, it must be stopped until the vessel has passed entirely through, and then must be moved back again. A double draw that is turned end for end at every passage of a vessel can be opened in little more than half the time required, if only turned a quarter around and then turned back again.

The material for these bridges and draws should be iron, because the most economical for an enduring structure, and lighter than wood for the construction of draws of the same strength.

Satisfactory draws, however, will be entirely ineffectual unless supplemented by measures to secure a more rapid passage of the vessels through them than is attained by floating on the tide or warping through by hand. Even with the draws now in use, the average time taken for the passage of the vessel is much longer than the time taken for both the opening and closing of the draw. Generally the vessels go stern foremost, without even the guidance of a rudder, and they float with the tide. Very frequently the vessel, in passing through, will be brought up in her course by striking against one side or the other of the drawway.

The use of the steam-tug is the most economical and the customary means of securing the rapid transit of vessels through draws, and where the steam-tug is used the draws should be so far above the water that the tug can pass under by dipping its smoke-stack. This saves opening the draw for the tug on its return, and in towing, allows the tug to pass the draw while it is opening for the vessel. As already stated, no vessel passes a draw in Chicago except in tow of a steam-tug, and with a tug, vessels pass up and down whenever they please. Can this practice be made to prevail on Fort Point Channel and Charles River?

Use of Steam-Tugs.

Upon Fort Point Channel, as it is to-day, we are satisfied that steam-tug navigation is entirely practicable. For two lines of vessels going in opposite directions, much might be done to improve the facilities of passage. Two draw openings would be better in every bridge than a single opening. Vessels going in one direction could be let through at the same time with vessels going in the other; whereas, in the case of a single opening, the vessels at the draw going one way must wait until those at the draw going the other way have passed through.

The Federal Street bridge, the Old Colony Railway bridge, and the Dover Street bridge, have single openings.

The Boston, Hartford and Erie Railroad bridge, the Mount Washington Avenue bridge, and the Broadway bridge, have double openings; but the easterly opening of the Broadway bridge cannot be used, as the lower portion of the pier joins on to the upper portion of the fender pier of the Old Colony Railroad bridge, and cuts off the drawway in the railroad bridge from all access from the easterly side of the channel below the Broadway bridge.

The draws, therefore, of the Boston, Hartford and Erie Railroad and Mount Washington Avenue are the only ones that have two openings, of which both can be used.

Again, to secure the full benefits of navigation by steam-tugs, the bridges should be built so as to admit the passage of the tug with lowered smoke-pipe under the closed draw at any tide. The Broadway bridge admits this passage now without even lowering the smoke-pipe. The Federal Street bridge is soon to

be rebuilt, and can be adapted to the passage of steam-tugs under the closed draw.

There would remain the Mount Washington Avenue bridge and the Dover Street bridge that would not have the requisite grade. The remedy, however, can be applied to these bridges whenever the demand for less obstruction to the land transit at these points becomes irresistible.

The Dover Street bridge might well be rebuilt if for no other purpose than to make here an elevated bridge which should pass over the track of the Old Colony Railroad instead of at grade, as it now does, across this street.

There would be less disposition to rebuild the Mount Washington Avenue draw, as it was only last year that the city of Boston put in a new draw here and made very extensive repairs on the bridge. The draw is a centre-pivot draw with a double opening, and was intended to be swung half around at every passage of a vessel, end for end. But, from defective construction or weakness of the old foundation, which is of piles merely, that are swayed every time a loaded vessel strikes against the fender pier, the draw can be turned but a quarter around at the passage of a vessel. Each end of the draw does not fit both ends of the bridge at the rests. One of the main advantages, therefore, of the centre-pivot draw, by which the draw had an uninterrupted movement from the opening to the closing, and the draw following the passing vessel was closed the moment the vessel has passed through, is, through this defect, lost. The delay caused by the movement of the draw would be reduced about one-half were this defect repaired. If to effectually repair this defect a new foundation were required, the draw could be raised to the requisite height for letting tug boats through without opening it, and the street and bridge graded up accordingly.

There remain, however, the Old Colony and Newport Railway bridge, and the Boston, Hartford and Erie Railroad bridge, which the hull of a steam tug could not pass under while the draws were shut. The grade of the draw in the latter railroad bridge could not probably be raised so that at all tides the hull of a steam-tug could pass under it; but it is understood to be the purpose of those in control of this railroad to move its station in Boston to the new land to be made on the South Boston flats on the easterly side of Fort Point Channel. This railroad

bridge will then be abolished, and new and satisfactory means of transit secured.

The same defect exists in the construction of the Broadway bridge as in the Mount Washington Avenue, and with the same result. It probably increases the delay five minutes every time a vessel passes the draw, and ought to be remedied. The obstruction to travel caused by this draw, as at present worked, must be felt by the public to be a great evil. It is proposed to put in steam-power to move the draw. When this is done, and the draw made to revolve half around at every opening for the passage of a vessel, a great improvement must necessarily follow.

Is steam-tug navigation practicable for Charles River? Until the alignment of the draws in the railroad bridges has been effected, the Board would not recommend it; but when that alignment of draws is completed, we have no hesitation in saying that it is perfectly practicable and ought to be required. The legislation already exists requiring the reconstruction of draws in the railroad bridges, and this has been done by the Fitchburg Railroad Company and the Boston and Maine Railroad Company. The Eastern Railroad Company has delayed its work, and gives as the reason the fact that the legislature has under consideration plans reported by a joint commission of the Harbor and Railroad Commissioners, that recommend the removal of the five existing pile bridges, and the substitution therefor of two iron bridges for the use of the four railroads crossing Charles River. The Boston and Lowell Railroad Company has begun, but not completed, its portion of this important improvement.

When the new draws are built in line, as shown on the plan annexed to the fourth annual report of this Board, as there is but a single drawway thirty-six feet wide in each bridge, and as from Warren bridge to the Boston and Lowell Railroad passenger bridge the bridges are very near together, it will be impossible to have two lines of vessels, going in opposite directions, pass at the same time over this portion of the river. But it will be very easy to signal from one end of this straight avenue of draws to the other when at either end a vessel has begun the passage; and, while the passage is making, the basins at each end of this avenue are ample to accommodate all the vessels that shall accumulate there waiting for their turn to pass through.

One side of this avenue, when completed, will present a straight and unbroken line of draw pier. Above the Boston and Lowell Railroad passenger bridge, vessels can pass each other going in opposite directions without difficulty. One tug could frequently take through several vessels together, and thus a good deal of time could be saved.

There is nothing to prevent this navigation by steam-tugs over Fort Point Channel and over Charles River when the improvement in draws shall have been completed, except the following rule enacted into a law by the legislature of 1855, seventeen years ago: "Railroad trains shall be allowed fifteen minutes to cross a draw before and after their time-table for being due, and a further reasonable time shall be allowed to any approaching train." The effect of this law is that vessels accumulate above, below and between the railway draws, waiting for the miserable chance the law gives them to go through. So frequent are the trains that vessels, on arriving at a railroad draw, must almost inevitably wait a long time before the legal opportunity can come; and as they are generally borne up and down these channels by the tide, the delay of a vessel near the turn of the tide practically delays her six hours until a new tide sets in.

It would be too serious a tax on every vessel passing over these channels to subject it to the necessity of paying for the enormous demurrage every steam-tug would be liable to under the operations of this law. Vessels now, unless peculiarly laden, rarely take a steam-tug on Charles River, although it sometimes takes a whole day to pass the four railroad passenger bridges.

On Fort Point Channel, where there are but two railroad bridges, and where a laden vessel would ground if delayed till the water is below half tide, the use of steam-tugs is more common.

The law is wrong in principle. Its object is to secure to the railroad company, whose bridge has obstructed the channel over which vessels have a legal right to pass, a passage for trains absolutely uninterrupted. The whole of the burden of detention is put upon the interest whose right of passage the railroad has obstructed. It is an unreasonable law in this respect. It makes the longest time a vessel takes for passing under less favorable circumstances than usual, the test by which to determine how long all vessels shall be detained. It applies the same

rule to the steamer and the sailing vessel, to the vessel without a tug and with one. A vessel that could get through in five minutes must wait fifteen minutes and more for the train that is five miles off, and by such detention be compelled to wait hours for a time when there is more than fifteen minutes interval between arriving and departing trains.

The law is made the same for Salem Harbor, in which a railroad draw is passed not more than half a dozen times in a year, and for Charles River, where such draws are passed ten thousand times in a year. What justice is there that a fleet of vessels and their cargoes should be detained hours, that railroad passenger trains may never be delayed even a few minutes, to enable a vessel to complete her passage through a draw? Injustice is done by this law not only to the interests of navigation, but to the whole travelling public having occasion to pass over the draws in the public highways crossing these waters, if this law stands in the way of securing less delay in the passage of vessels through these highways by the use of steam-tugs.

The people of Cambridge, Charlestown and South Boston should understand that they are kept waiting while a sailing vessel takes from five to fifteen or twenty minutes in blundering through a draw on Charles River or Fort Point Channel, which could be towed through by a steam-tug in from one to three minutes, in order that railroad passenger trains may have a monopoly of uninterrupted passage over these navigable tide-waters.

The statistics for these highways, of the passengers that are unnecessarily obstructed through the maintenance of this law, as gathered by the Harbor Committee of the legislature of the year 1871, and a comparison of the number of passengers passing daily over Fort Point Channel and Charles River by railroad and highway bridges respectively, is contained in the following table:—

Table showing the respective number of Passengers passing over Fort Point Channel and Charles River by Railroad and Highway Bridges.

No.	NAMES OF BRIDGES.	No. of Passengers.
FORT POINT CHANNEL.		
1	Old Colony and Newport (in 1870),	2,381,190
2	Boston, Hartford and Erie (in 1870),	792,155
	Both carried in 313 days,	3,173,345
	Average passengers per day over Fort Point Channel by railroads,	10,139
	Average passengers per day over Fort Point Channel by the highways,	51,205
	Excess of highway passengers over railroad passengers per day,	41,066
CHARLES RIVER.		
1	Fitchburg (in 1870),	1,356,654
2	Boston and Maine (in 1870),	2,500,000
3	Eastern (in 1870),	2,645,709
4	Boston and Lowell (in 1870),	1,317,871
	All carried in 313 days,	7,820,234
	Average passengers per day over Charles River by railroads,	24,984
	Average passengers in 12 hours over Charles River by the highways,	39,097
	Add one-quarter more for 24 hours,	9,774
		48,871
	Excess of highway passengers over railroad passengers per day,	23,887

From this comparison of the number of passengers passing over Charles River and Fort Point Channel by the highways, with the number of passengers passing over them by railroads, it would seem that if any class of persons are to have the monopoly of facilities for passing draws, it is the highway travellers, and not the passengers by rail. But no class should have the monopoly of such facilities, and no class should be made to bear the whole of the inevitable delay to travel that results from the intersection of the lines of land and water transit, still less should the minority in number and weight of interest be made that privileged class.

All should bear their share of the burden, and the burden should be made as light as possible, and by properly distributing the burden it will become the interest of each to make it as light as possible. If railroad trains are made liable to slight detentions while vessels pass their draws, it will be for their interest to open and close their draws as quickly as possible, and to increase the facilities of passage, when trains are not running.

If vessels will pass through with tugs, there will be some inducement to construct draws upon approved models.

The following table represents the number of outward passenger trains from Boston in 1855, when this law was enacted, and 1871, over the railroad bridges across Fort Point Channel and Charles River, and the passages of vessels in 1855 and 1871 through the Federal Street draw close to the Old Colony Railroad draw, and the Warren bridge close to the Fitchburg Railroad draw.

Outward trains.

Old Colony, in 1855,	.	.	.	.	.	.	.	18
in 1871,	.	.	.	.	.	.	.	27
Fitchburg, in 1855,	.	.	.	.	.	.	.	14
in 1871,	.	.	.	.	.	.	.	19
Boston and Maine, in 1855,	.	.	.	.	.	.	.	20
in 1871,	.	.	.	.	.	.	.	32
Eastern, in 1855,	.	.	.	.	.	.	.	10
in 1871,	.	.	.	.	.	.	.	30
Boston and Lowell, in 1855,	.	.	.	.	.	.	.	14
in 1871,	.	.	.	.	.	.	.	25

Passages of vessels.

Passages of vessels through Federal Street draw,—

In 1855,	.	.	.	.	.	.	.	4,542
In 1871,	.	.	.	.	.	.	.	10,851

Passages of vessels through Warren Bridge,—

In 1855,	.	.	.	.	.	.	.	4,092
In 1871,	.	.	.	.	.	.	.	7,123

This rule, at the time it was made, might be tolerated by a patient people, but, with the changes that have since taken place, it has come to be felt in its effects as an intolerable and oppressive grievance, and should be repealed.

This statute could not have been maintained so long except

by having become erroneously considered to be a safeguard to railroad trains from accident. On the contrary, the tendency of the rule is to promote accidents rather than prevent them, because the effect of it is to relax the watchfulness of the engineer. A rule that makes it about certain that the draw will be safe increases the probability that when a vessel is more than fifteen minutes in passing through it, and the draw is, in consequence, open at the arrival of the train, the engineer will not notice the fact.

A drawway is a dangerous place, like a crossing of another railroad track at grade, and an engineer should have the feeling that it is always dangerous, that he may always take the precaution necessary to make the passage always safe. It would be safer for trains if the draws were, in fact, and known to be, always open when reached by trains, than to be known to be almost never open. Subsequent legislation shows that this provision was not considered a security against accidents. In 1863 an Act was passed, chap. 138, requiring that railway drawbridges should be furnished with conspicuous signals, "which shall be displayed at all times in such manner as clearly to indicate to the engineer of an approaching train the position of the draw, whether open or closed." (Sect. 3.) Provision is also made for the erection of gates across the track at a distance of five hundred feet, more or less, as may be determined by the county commissioners, so constructed that the opening of the draw shall throw the gate across the track. (Sect. 4.) It is further provided (Sect. 5) that if any such drawbridge is not furnished with these gates, "and in all cases where, by reason of darkness or otherwise, the gates or signals connected with any such drawbridge are not visible from the engine of an approaching passenger train, the engineer of such train shall bring the same to a full stop at a distance of not less than three hundred nor more than eight hundred feet from such drawbridge, and shall, before proceeding, positively ascertain that the draw is properly closed for the passage of trains: *provided, however*, that where such drawbridge is between two railroad crossings at grade within six hundred feet of each other, one stop only shall be required for such crossing and drawbridge." Here is a statute that provides absolute security for trains passing over draws against their being precipitated into the drawway. None

of the railroads crossing over Fort Point Channel or Charles River are provided with such gates. None of these draws are between grade crossings six hundred feet apart. Trains of cars must, then, all stop at these drawbridges at any rate, whether shut or open. How slight an additional detention it would be for the trains not to proceed until a vessel passing through rapidly in tow of a steam-tug should complete her passage and the draw be closed! The new draw of the Fitchburg Railroad Company is opened by two men in forty seconds. A minute should suffice for a tug to take a vessel through whose headway was not checked by delay in opening the draw. As the train must stop at the draw, whether closed or not, the additional delay caused by the passage of a vessel is a trifling detention when compared with delays sometimes of a day, and, generally, of hours, that vessels are now subject to, and the delays on the highways which the public at large sustain by reason of the obstacle which the existing law presents to the general use of steam-tugs on the channels under consideration.

As a relief to travel on both railroads and highways, it is desirable that the drawways should be kept at night well lighted, and in the interval between the last train at night and the first train in the morning, open all the time, that as many vessels as possible may be induced to pass the draws during a period of time when there is no passing over the bridges.

There is also an unreasonable rule enforced, as a matter of city regulation, in regard to the passing of draws in the highway bridges. But one vessel can pass through at a time, if persons are on the bridge waiting to pass. But certainly if one vessel requires seven minutes to pass, and two together can pass in eight minutes, it is better that those on the bridge should wait a minute more rather than that another like body of persons should be compelled to wait seven minutes for what could have been done before in one. The true principle would seem to be to give the land transit and water transit their turns at passing if the two are in competition. The water-way should be open a certain length of time for all the vessels that can pass in that time, whether one or more, and the land transit should then be allowed to resume its course for another period of time, each class having a length of time assigned it proportionate to the tendency in that class to be accumulated by detention.

A new Bridge between Boston and Charlestown.

The expediency of a new bridge between Boston and Charlestown, in place of the Charles River and Warren bridges, is a question which has been much discussed, and belongs to the subject under consideration. Not that the reduction of the number of draws to be opened, to one is of itself to give any relief, for, as the amount of travel on both bridges would be concentrated on one, the same amount of travel would be delayed by the opening of one draw that was before delayed by the opening of two. But the draws now in use in these bridges are retractile draws, and not of that model that insures the least detention of travel. The characteristics of the true model for a draw have been already discussed. And this model has been found in the centre-pivot draw, with double openings when practicable, an easy width of waterway, and a roadway on the draw itself of the least practicable width that shall accommodate the travel.

This draw also should have such a grade as would allow the passage of the hull of a steam-tug under it at any stage of the tide. The grade of the present bridges could not be raised without substantially rebuilding them. They are too old to be worth rebuilding. If this grade were not to be raised, it would be poor economy to build in them two first-class draws with their piers, when this cost would be a substantial contribution to the construction of one new bridge which could be so built as to answer every purpose. It was these considerations, and the belief that soon a single bridge must be built in place of the present bridges from Charlestown to Boston, that led this Board to approve a plan for a new draw in the Charles River bridge that would not require the building of new and expensive piers. It was intended to be a temporary structure.

One bridge, it is believed, will furnish sufficient connection between Boston and Charlestown. The fact that two bridges now exist does not have any tendency to show that two are needed where they are located, when it is considered that the Warren bridge was built as a competing bridge with the Charles River bridge, because a private corporation had a monopoly of the only roadway leading directly from Boston to Charlestown.*

* The new roadway built across Charles River, from the freight station of the Fitchburg Railroad Company to the Boston terminus of Warren bridge, will take all the

The Board has selected Charlestown Street on the Boston side, and the terminus of the Charles River bridge on the Charlestown side, as the termini of the proposed bridge. These will make the bridge a continuation of Washington Street when it shall have been extended to Haymarket Square. It will be near the line of the larger of the two bridges, and will not interfere with business that has already adjusted itself to this line of transit. The Warren bridge can stand until the new one is completed.

To obtain plans and estimates for such a bridge of iron and of approved construction, the Board had recourse to the engineer of the New England Iron Company, Mr. Edmund H. Hewins, who has had experience in building bridges and draws in the West and in Massachusetts. A plan of the elevation of the bridge is appended to the Report, and the statement of Mr. Hewins in regard to its cost and movement. It would be 800 feet long, and would cost, with the iron piers shown in plan, 100 and 125 feet wide, as follows:—

800 × 100 = 80,000 sq. ft. at \$7.00 per sq. ft. .	\$560,000 00
800 × 125 = 100,000 " " " " .	700,000 00

Should stone piers be used, and the Board would recommend them as preferable to iron ones, then the cost would be as follows:—

800 × 100 = 80,000 square feet, at \$5 per square	
foot of superstructure,	\$400,000 00
Stone piers,	300,000 00
	<hr/>
	\$700,000 00
800 × 125 = 100,000 square feet, at \$5 per square	
foot of superstructure,	\$500,000 00
Stone piers,	375,000 00
	<hr/>
	\$875,000 00

It would be necessary to grade at each end the approaches of the bridge for about two hundred and fifty feet. This, however, would not make the land damages a very serious addition to the cost. Mr. Hewins estimates that the draw in this bridge teaming from the freight-yard of the company, and be substantially, for nearly all practical purposes, a public way in place of Warren bridge.

having double openings sixty feet in width and with a width of draw of forty feet, could be opened in one minute with the use of an hydraulic engine, which would cost not more than seven hundred dollars, and be the least expensive power that could be applied.

This draw is of the same construction as the draw at Clinton, Iowa, over the Mississippi River, 300 feet long, with draw openings 132 feet wide, which opens in one minute, and the draw at Keokuk, Iowa, over the same river, 370.5 feet long, with openings 160 feet wide, the largest centre-pivot draw in the world, which opens in two minutes. The estimate, therefore, of Mr. Hewins would seem to be a very safe one.

We see no reason why the average delay caused by the passage of a vessel through the proposed draw with a steam-tug cannot be reduced to two minutes. The Board, in its estimates and plans for a bridge between Boston and Charlestown, has not undertaken to determine the true width that should be adopted. It has assumed such widths as it is found were generally considered necessary by engineers and officials who had considered the subject. It is a question, however, of very serious importance, and an element in this problem of improved facilities to be solved, whether a bridge connecting avenues on either side of a water-way, like Charles River, need be as wide as the avenues themselves, to afford the same freedom for continuous travel; and still further, as we have already argued, whether a drawbridge need have the full width of the bridge proper.

Should it be proved, however, that the pressure of travel over a single bridge to Charlestown will absolutely demand the extreme width of 100 or 125 feet, and that a corresponding or nearly equal width of drawbridge is required, then we advise, instead of a bridge of such a width with a single surface, a narrower bridge and draw with double decks, say one of 60 feet in width. This will give the travelling capacity of a single bridge of 120 feet. A drawbridge 120 feet wide and spanning openings of 60 feet will need to be 240 feet in length, while a draw 60 feet wide, spanning the same, will be but 180 feet long, —the surface extent of each being as 28 to 10.

So vital do we consider the minimum size of a draw in the question of least delay and interruption to both the land and

water transit of a bridge, that we urge the consideration of the double-deck bridge on this ground alone, as giving, in a bridge of so great capacity, a draw so much narrower, shorter, lighter and more easily moved and managed. The passage of a vessel through the bridge is, of course, reduced to one-half the time.

There are no practical difficulties or objections to such a structure at the site proposed. There are even points of advantage in some of its peculiarities.

By dividing and classifying the kinds of travel, increased facility of movement may be obtained, as, for instance, appropriating the lower deck for horse-cars and for loaded teams, which maintain a generally uniform degree of speed, and giving the upper deck to buggies, hacks, express wagons and all such vehicles as would prefer a roadway free from horse-car rails and slow-moving teams.

The grades for reaching the upper deck of the bridge can be made in the same general style of structure as the bridge, but at less cost, while a large proportion of the space under the ascending and descending ramps can be utilized as storehouses.

We give below approximate estimates for such a bridge. As will be seen by the figures, a large saving is made in the item of piers.

Double-Deck Bridge, 60 feet wide.

1st deck, $800 \times 60 = 48,000$, @ \$5,	\$240,000 00
2d deck, at 75 per cent. of above,	180,000 00
Ramp, Boston side, $300 \times 60 = 18,000$, @ \$3,	54,000 00
Ramp, Charlestown side, $500 \times 60 = 30,000$, @ \$3,	90,000 00
	<hr/>
	\$564,000 00
Piers (nine),	162,000 00
	<hr/>
	\$726,000 00

Single Deck, 120 feet wide.

$800 \times 120 = 96,000$, @ \$5,	\$480,000 00
Piers (nine),	360,000 00
	<hr/>
	840,000 00

Balance in favor of double-deck bridge,	\$114,000 00
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The measures, then, that seem the best to secure the relief of traffic over Charles River and Fort Point Channel are as follows:—

First.—The abolition of so much of section 76, chapter 63, of the General Statutes as requires an allowance of fifteen minutes before and after a train is due, for the passage of a vessel through a railroad draw.

Second.—The requirement that all vessels shall use steam-tugs in passing draws.

Third.—The substitution for the regulation that one vessel only shall pass through a highway draw at a time, of a regulation fixing a little more than the average time for the passage of a vessel through a given draw, as the time during which the draw may be open and as many vessels may pass through as can.

Fourth.—The adoption of centre-pivot draws, which, when practicable, shall have double openings, and to secure lightness of weight and rapid movement, shall have the least possible width, which shall relieve the accumulations of teams caused by the passage of vessels, without adding to the delays of the land transit.

Fifth.—The adoption of such a grade to the highway bridges that a steam-tug with its smoke-pipe lowered can pass under them at any tide.

Sixth.—The application of such power, whether hand, steam or other power, as shall open the draw with proper precision and rapidity.

Seventh.—Such working of the draw that it will not be necessary for a vessel to come to a stop before passing it. A bridge tender should be always on the lookout for the approach of vessels, that he may in quick succession stop the land transit and without any check to their headway let vessels pass through.

Eighth.—The substitution of one first-class bridge between Charlestown and Boston in place of the present Charles River and Warren bridges.

Tunnels.

By means of tunnels, however, all conflict between land and water transit over these channels can be entirely obviated.

The perfect success of the Chicago tunnels has demonstrated this fact.

A tunnel under Detroit River, to connect the Grand Trunk Railway of Canada and the Michigan Central, has already been begun and is to be constructed by tunnelling. One to carry a street under the Harlem River near New York is projected, to be built in an open cut. Tunnels under the water are discussed in many other places, abroad and at home, and henceforth we shall undoubtedly see many of these structures built.

For the construction of a tunnel under Fort Point Channel substantially the same conditions are presented as at Chicago. The bottom would be at about the same depth and it could be built in the same way by means of coffer-dams. Charles River, particularly the section between Charlestown and Boston, in consequence of the great depth of water, thirty feet at low tide, presents greater but by no means insuperable difficulties.

In order that a definite idea might be obtained of the probable expense of applying this method of obviating the conflict of land and water transit to the channels under consideration, the Board obtained the coöperation of Mr. Clemens Herschel, of Boston, a competent engineer, who had already devoted a good deal of study to the subject and had professional relations with the great master of this branch of engineering, E. S. Chesbrough of Chicago. We have therefore obtained plans and estimates from Mr. Herschel for tunnels between Charlestown and Boston on the line of the proposed new bridge, and from the foot of Summer Street to South Boston.

The plans show the location and forms of cross-section of each as proposed by way of a preliminary study; careful designs fitted to each locality would reduce the estimates by the substitution in part of less costly materials at sections where it may be done with safety. Two estimates are given for a tunnel between Charlestown and Boston,—the one, for a tunnel to consist of open approaches twenty feet wide in the clear, and having under the channel two drive-ways 11 by 13 feet, and one sidewalk 10 by 10 feet, as shown in the appended plans; the other for a tunnel with open approaches 40 feet wide and otherwise a duplicate of the one first described, thus accommodating two horse-railroad tracks and two drive-ways, each 11 feet wide, besides two sidewalks, each 10 feet wide. Such a cross-section is believed to be ample for all contingencies. The grade estimated for viz., 3 : 100 is easy and beyond cavil.

The land damages would be exceedingly small, as the tunnel could be covered over at its very beginning, and the second and other upper stories, so to speak, used for various purposes. Where it is below ground, the final land damages are of course exceedingly small or nothing. In the construction of the Chicago tunnels in some fourteen to sixteen feet of water, ordinary coffer-dams were used to keep out the water.

In the case of the Boston and Charlestown tunnel, with about forty feet of water to work in at high tide, recourse may be had to an iron coffer-dam, which is a contrivance of Mr. Herschel's, and is shown on the appended plan.

The manner of using it is simple, and the whole design, though new, is not so new as to rank as an entirely novel and untried experiment.

The space between the inside and outside walls of the coffer-dam is divided into compartments, each of which at its lower end constitutes a pneumatic chamber and is to be sunk as such.

This process has now become well known since the use made of it in sinking the foundations of the St. Louis and East River bridges. Almost the only novel feature in Mr. Herschel's plan consists in fitting this coffer-dam to the tunnel. For this purpose the tunnel is built with rings or belts upon it, the better to receive the end wall of the coffer-dam.

The following table gives the principal dimensions and cost, actual and estimated, of the two Chicago River tunnels, and tunnels over Charles River and Fort Point Channel, and other features of those works :—

NAME OF TUNNEL.	Depth of water built in, in ft.	Grades of Approaches.	LENGTH IN FEET OF				Form of Cross-Section.	Actual or Estimated Cost.
			Open Approach, about,	Shore Tunnel, about,	River Tunnel, about,	Total, about,		
Washington Street, Chicago, . . .	14 to 16	$\left\{ \begin{array}{l} 5 \frac{31}{6} \\ 6 \frac{25}{25} \end{array} \right. 100 \left. \right\}$	= 592	= 711 $\frac{3}{4}$	= 222	= 1,525 $\frac{3}{4}$	$\left\{ \begin{array}{l} 2 \text{ driveways, } 11 \times 13, \\ 1 \text{ sidewalk, } 10 \times 8, \end{array} \right\}$	\$395,664 48
La Salle Street, Chicago, . . .	14 to 16	5 : 100	600	1,030	222	1,852	$\left\{ \begin{array}{l} 2 \text{ driveways, } 11 \times 13, \\ 1 \text{ sidewalk, } 10 \times 10, \end{array} \right\}$	461,093 74
Charlestown to Boston, . . .	30 to 40	3 : 100	1,266	2,200	1,000	4,466	Same as above, . . .	1,762,832 00
Charlestown to Boston, . . .	30 to 40	3 : 100	1,266	2,200	1,000	4,466	Double the above, . . .	2,979,418 00
Foot of Summer St. to So. Boston, . . .	12 to 22	$\left\{ \begin{array}{l} 4 \\ 4 \frac{1}{2} \end{array} : 100 \right\}$	= 950	1,050	500	2,500	$\left\{ \begin{array}{l} 2 \text{ driveways, } 11 \times 13, \\ 1 \text{ sidewalk, } 10 \times 10, \end{array} \right\}$	882,470 00
Detroit River (tunnel proposed), . . .	about 50	1 : 50	$\frac{1}{2}$ mile.	6,250	3,000	11,850	Double tun., 2 R R. tracks,	*2,650,000 00

* Estimated.

In concluding this branch of the subject, the Board desire to acknowledge its great obligations to Mr. E. S. Chesbrough, the City Engineer of Chicago, for the facilities furnished its committee while at Chicago for examining the public works of the city, and the valuable information he has given the Board, and Mr. Herschel for the preparation of the statistics, plans and estimates submitted in this Report. The only question remaining is the expediency of building tunnels over Fort Point Channel and Charles River. This is partly a question of accommodation to land transit, partly one of commercial facilities.

Tunnels for Boston.

As a question of accommodation to travel the answer depends upon the extent of this travel to be accommodated with uninterrupted transit.

If this tide of travel is large and constant, if the slightest interruptions possible with bridges frequently induces large accumulations of teams and passengers, it is economical and expedient, almost a necessity, to build a tunnel.

If the injury a bridge always does to the commercial water-front of a port is a substantial injury to its facilities for commerce that are needed and used, if the building of a new bridge would destroy a valuable and frequented water-front, or the removal of the bridge would restore such a water-front to the port, then the tunnel should be built as a means of preserving or restoring to use needed commercial facilities which are the very life of a commercial port.

It does not seem to the Board that any of the avenues over Fort Point Channel, except Federal Street, are sufficiently crowded to justify at present the requisite expenditure for a tunnel.

Nor is the character of the water-front from the foot of Summer Street to Dover Street bridge such as would justify the expenditure of over a million of dollars to relieve it of the Mt. Washington Avenue bridge and the Dover Street bridge, and the expenditure of some six hundred thousand dollars more for a tunnel instead of a bridge in the extension of Eastern Avenue.

A tunnel could be built across Fort Point Channel in place of the Federal Street bridge, at very little greater cost than that of the La Salle Street tunnel in Chicago,—in round numbers, half a

million of dollars, or three hundred thousand dollars more than the new bridge there, the plans for which the city government has now under consideration.

If, however, the Boston and Albany Railroad Company shall find it for their interest to connect their track with the South Boston flats by a tunnel crossing the line of Federal Street under Fort Point Channel, as the Board earnestly hope may be the case, and as may be done for substantially the same cost as by raising the grade of streets, it would be impracticable to construct another tunnel for land travel at the same place.

As regards the expediency of a tunnel over Charles River, in place of the two bridges now existing, it is the opinion of the Board that the advantages to the land transit that would be obtained by a tunnel are not so much greater than those that could be obtained by a first-class bridge, as would justify the additional cost, amounting to some two millions of dollars.

A single bridge of proper construction would not, with double the amount of passing that now exists between Charlestown and Boston, be subjected by the passage of vessels to excessive accumulations of passengers and teams. This being so, there is one disadvantage inseparable from any tunnel built in this locality, that must be reckoned as an offset to the delays on a bridge from open draws. To secure an outlet to the tunnel at Charlestown Square, which, in consequence of the grade of the city beyond, is the point farthest from the river at which an outlet can be had, the tunnel must make a detour from its main course and a return upon it again, amounting in all to some one thousand feet increased length of way, for the mere purpose of gaining the requisite grade to come out at the proper terminus.

Every team must go so much further by this distance and lose the time and power spent in so doing. With a bridge, not every team would be stopped by an open draw, and if stopped would be delayed no longer probably than in going a thousand feet, and there is no loss of power in standing still. Foot passengers would go no further by the tunnel than the bridge, as there would be steps on each side of the river for descent and ascent to and from the foot-ways.

When, however, the project of a tunnel between Charlestown and Boston is considered in its relation to the water-front on

Charles River above the line on which the new bridge would be located,—a water-front capable of supplying much-needed commercial facilities, and which in a near future we cannot but believe will be considered as among the most valuable in Boston Harbor,—another class of considerations besides the greatest economy with which convenient communication between Boston and Charlestown can be had across the line of Charles River, ought to have an influence in the decision of the question.

Under the instructions of the legislature of 1870, the Harbor Commissioners and Railroad Commissioners were made a joint commission to report to the legislature of 1871 a plan in which the demands of the railroads on the northern side of the city of Boston for increased terminal facilities might be met, and the interests of the harbor and navigation promoted. That report showed,—

First.—That the intersections with each other of the tracks of the Fitchburg, Boston and Maine and Eastern railroads, was fraught with danger to the lives of passengers, and becoming more and more so every year with the multiplications of trains.

Second.—That the great mass of badly constructed pile bridges on which these railroads were brought over Charles River was a great injury to the harbor of Boston.

Third.—That by placing the station of the Fitchburg road above that of the Boston and Lowell road, and the station of the Boston and Maine road above that of the Eastern, and substituting two double-decked iron bridges with spans of a hundred feet, in place of the five hulks of piles and timber, with twenty and more acres of surface, that dam the flowage of the river, both the peril to life and the peril to the harbor could be obviated.

Fourth.—That with such a reformation in the railroad bridges, a large area could be spared from the bed of Charles River and Miller's River, for increasing the terminal facilities of the roads, and a splendid basin of the deepest water, sheltered from every violence of wind or sea, having a perfect water-front for every kind of shipping, would thus be formed in juxtaposition with the termini of these great lines of railroad transportation.

A moment's reflection must show the importance of these waters, now so shamefully encumbered and made worse than useless.

At this point on Boston Harbor terminate four lines of railroad, two having communication with New Brunswick, two with Canada; one now, and with the completion of the Hoosac tunnel, two, with the great West, and all the country between. Right along by the side of the depots and freight-houses of all these roads, can be brought by means of this basin, thirty feet deep at low water, every kind of vessel, from the coasters laden with lumber and coal, to the great ships and steamers of an international commerce. We doubt whether there is in all the United States a harbor basin of its size, so perfectly adapted as this to be the point of commercial contact between the lines of transportation on both land and sea.

The omens multiply every year that Boston is to attain an ascendancy in foreign, corresponding to her achievements in domestic commerce. The last year has witnessed the restoration to her, of lines of European steamers sailing oftener and in every way established on a more liberal basis of accommodation than ever before, and an accumulation of Western products seeking here an outlet for foreign export.

These are but the beginnings of a tide in her affairs, whose flood, it is firmly believed, will tax to their utmost all her great capabilities for maritime commerce.

If the work is to be begun of restoring to Boston Harbor these waters that have been so wrongfully, needlessly and injuriously wrested from it; if they are to be cleared of the disgraceful structures that now encumber them,—then there ought not to be a single bridge from the mouth of the Charles river up to the line of the two new railroad bridges near Cragie bridge, to mar the perfect harbor basin that would result from this improvement. For the sake of the basin the tunnel should be the means of communication between Boston and Charlestown, and we recommend a tunnel for this purpose as incidental to a plan for the restoration of this basin to commerce.*

Such a plan is contained in the joint report of the Harbor and Railroad Commissioners to the legislature of 1871.

*Further reflection has led us to believe that an improvement can be made on that plan by transferring the stations of the Boston and Maine and Eastern railroads to the eastern side of Causeway street, assigning their locations in the order already stated, and so carrying the new bridge for these roads close to the bridge for the other two roads near Cragie bridge.

GOVERNMENT WORK IN BOSTON HARBOR AND ELSEWHERE.

Since Gen. J. G. Foster was ordered by the War Department upon important service in the West, the government work in Boston Harbor and elsewhere in the State, has been in the charge of Gen. George Thom of the U. S. Engineers. While regretting the loss to the State of so able an officer as Gen. Foster, the Board is happy to report that the work for the protection and improvement of the harbors and navigable waters of the Commonwealth has made most satisfactory progress under the efficient direction of his successor.

The works in Boston Harbor now in progress are sea-walls for the protection of Point Allerton, Gallop's Island and Long Island Head, the complete removal of Kelley's Rock and the deepening of the channel through the Upper Middle Bar. This channel is to be opened to a depth of twenty-three feet at mean low water, and to a width of six hundred feet.

We are permitted by Gen. Humphreys to append Gen. Thom's report to him of his operations in Massachusetts during the last six months of the past year. Although the work in Boston Harbor is the only work that is being done in response to the application to Congress of this Board, this admirable summary of all that the government is doing for the navigable waters of the State, is of such public interest and value that we are glad to be able to communicate it to the legislature.

PROVINCETOWN.

In consequence of a large number of applications to the Board for licenses under chapter 268, statutes 1867, to build or extend wharves in Cape Cod Harbor, and the importance of granting these licenses upon some general plan, so that the wharves shall not interfere with each other when extended to the commissioners' line, the Board held a public meeting in Provincetown on the 14th day of June, at which it submitted to the citizens of the town such a scheme for the construction of wharves in the harbor. It was unanimously acceptable, and many licenses have since been granted in accordance with this plan.

As the Commonwealth is still the owner of the province lands in Provincetown, the authority of the Board under the statute cited, to control the location of wharf structures extended to the high-water mark.

There was no difficulty, therefore, although the harbor is a circular cove, in presenting a system of lines on which wharves could be built. When, however, the grant of the State in a circular cove is intended to cover tide land that is outside of a continuation of the flats that belong to a shore owner, it is impossible to locate the grant without knowing where the flats of shore owner appurtenant to his upland, lie. Only a judicial determination of the boundary lines of these flats can be a binding one. The Board ought, therefore, as incident to its duty to locate legislative licenses on tide land, to have authority to submit to the adjudication of the supreme judicial court, under chapter 338, statutes 1871, a plan of the division lines of the flats appurtenant to the upland. These lines being settled by judicial decision, the Board could locate the legislative grant or license by extensions of these division lines. Some such legislation seems to be indispensable.

EDGARTOWN HARBOR.

The attention of the Board was called early in the season to the closing of the outlet of Cotamy Bay through Cotamy Beach in Edgartown about two years ago, to the local interests injuriously affected thereby, and particularly the State and national interests imperilled by the injury with which this closure threatened Edgartown Harbor itself.

Edgartown Harbor, being at the upper end of Cotamy Bay, and the outlet through the beach at the other, the effect of the destruction of the outlet was to destroy the circulation of the tides through the harbor, diminish the scour and induce a tendency to shoaling.

The question to be investigated was, whether by artificial means the outlet could be made again and the tidal effects restored, and where and under what circumstances this outlet should be made.

Our attention was also directed to evidences of changes going on in Vineyard Haven that had excited apprehension, and to the question of the expediency of cutting an outlet through Haulover Beach in Nantucket. These inquiries were so important, so difficult and so technical that the Board applied to Prof. Benjamin Peirce, the Superintendent of the United States Coast Survey, for his coöperation in making the investi-

gations. He had on previous occasions, when difficult problems relating to tide-waters had been presented, affecting large public interests, given the Board and the Commonwealth, in a very liberal manner, his most efficient aid. We quote from his letter in response to this application in behalf of Edgartown, the following extract :—

“The vicinity of Edgartown has been for many years interesting to the Coast Survey because of the changes there in the outer beaches and because of the remarkable tidal phenomena which occur there. As long ago as 1846 Lieutenant (now Rear-Admiral) Charles Henry Davis called the attention of scientific men to the physical changes that were in progress along the shores of Nantucket and Martha’s Vineyard, and in the same year Assistant H. L. Whiting made his complete topographical survey of the island and its shores.

“My own connection with these particular studies goes back officially as far as 1855, when the problems arising from Mr Mitchell’s tidal investigations were referred to me for solution by my predecessor.

“Aside, however, from these considerations which give me and my associates a personal interest in the locality to which you recall our attention, the fact that the harbor to which you refer is a *port of refuge* and the only perfectly safe and accessible one between Provincetown and Newport entitles it to watchfulness, especially when fears for its safety have arisen among a very intelligent community and arrested the attention of your Board.”

The topographical survey was placed in the hands of Prof. H. L. Whiting who in the years 1846 and 1855 had made similar surveys in the same neighborhood.

The physical hydrography was assigned to Prof. Henry Mitchell, who had in his possession the details of the tidal investigations made by him throughout the sounds and their approaches in the years 1854 and 1855. These gentlemen are at the head of their respective departments in the Coast Survey, and would have been the persons selected had the propositions originated on any part of the coast, but their familiarity with our own shores has been of such long standing and so intimate, recently in an especial manner through their connection with this Board, Prof. Whiting as its engineer and Prof. Mitchell as a member of its advisory council, that they brought to the work a particular interest and preparation.

The comparison which Prof. Whiting makes of previous surveys of this beach and the opening through it develops a singular history and exhibits in a vivid manner a phase of the changes that are continually taking place on this most interesting shore.

In 1846 this opening was at the eastern corner of the bay and formed a broad inlet about 2,000 feet wide of substantially the same character and location as shown by the survey of Des Barres in 1776. In 1856 this opening, called the East opening, had moved about a mile to the eastward so that the point of the beach overlapped the end of Chappequidick Island more than half a mile and formed an inlet between the island and the beach from the ocean to the bay, about 3,000 feet long and 500 feet wide. A new inlet, however, called the West opening and some 1,400 feet wide had broken through the beach at about the middle of the bay, having a capacity nearly as great as the old one. Soon after this last opening was formed the East opening closed and the new West opening gradually moved eastward until it reached that part of the beach which was the site of the opening found by the survey of 1846 and shown on the maps of Des Barres, then moved eastward to the site of the easterly opening found by the survey of 1856, and on until the point of the beach formed a line with the general trend of the east shore of the island. Here it met the rapid currents of Muskeget Channel and its progress was arrested. Finally, in a great storm, the sea and wind whelmed this channel between the island and the beach with masses of sand blown from the shore and scooped up from the ocean bed, and made a solid barrier against the further egress of the waters of Cotamy Bay. There is a tradition in Edgartown that once before, since the beginning of the century, this beach was welded to the island by a storm and that soon after another storm drove another inlet through. The powerful action of the sea on this exposed and sandy shore is shown by the statement of Professor Whiting that during the last twenty-five years this beach, representing a mole of sand 18,500 feet in length, 450 feet in width, 14 feet high and containing one hundred and sixteen millions and a half cubic feet, has been driven before it by the ocean, 450 feet.

With reference to reopening the outlet of the bay through

the beach, Prof. Whiting argues in favor of making it at the westerly corner of the bay in order that, if it again goes through the same phases of movement towards the east until it again closes, this movement may be made to cover as long a period as possible. He finds the bay here contracting to a narrow width that favors the formation of a channel and that here too the beach has the smallest cross-section to cut through. He finds the project practicable, and the exigency an imperative one.

Prof. Mitchell reports that in comparing the hydrography executed by his assistant, Mr. Marindin, with that executed by Lieut. (now Rear-Admiral) Davis twenty-four years ago, he finds a slight deepening over the bar of Edgartown which he presumes from the nature of the bottom to be nothing very recent, and a drift of sand across the bed of the main channel opposite the town, which he would have supposed from its volume to have been long accumulating had he not by inquiry among intelligent citizens of the neighborhood ascertained that it was not noticed until the closure of the outlet through Cotamy Beach, only two years ago. He therefore regards this shoaling as a symptom of deterioration already in rapid progress. The circulation through this harbor consequent upon its double entrance, had attracted the attention of Admiral Davis during the progress of his survey, and he had happily made those observations now most valuable for comparison with present conditions. Prof. Mitchell states that the closing of this beach has not only weakened the flow of the currents very materially, but actually *reversed* their order, so that the former regimen is utterly destroyed. It is safe to predict that changes of depth must follow and there is every reason to suppose that this change will be for the worse, because there is no reason why the bar of Edgartown Harbor should not shoal up like that of Nantucket and other sandy ports in the neighborhood, that have but one outlet. His conclusion is, that the restoration of this outlet and its former function is practicable and that the work should be done. As a part of the physical hydrography, the operations of the sea upon the shores were examined and comparisons instituted between Cotamy, Haulover (Nantucket), and Scituate Beaches, which showed that these natural dikes wherever ~~distributed~~ by the winds are of about the same elevation and give similar curves of cross-section.

undisturbed

This disposes Prof. Mitchell to think that the dry portion of the Haulover at the head of Nantucket Harbor is itself a creation of the sea, but he nevertheless gives great weight to the testimony of citizens of Nantucket who in digging into this beach discover much harder material underlying and he would not discourage an attempt to make an inlet through this beach.

For both Edgartown and Nantucket, tables and directions are given by Prof. Mitchell for making a proper choice of time for making the opening so as to secure the greatest rush of water and thus induce nature to execute the larger part of the work.

When it is considered that this narrow Cotamy Beach now separates two wholly different tidal systems which formerly blended together by means of the two outlets of the bay, one cannot but be impressed with the closeness of the observations and the precision of the scientific deductions that enable him to indicate the hour and the minute when the beach may be opened with every guarantee that the ancient tidal regimen will be restored.

The surveys of Vineyard Haven which were very thorough, have not yet been fully compared with previous work in the same neighborhood, because of the time required to make such comparisons.

The reports of Professors Whiting and Mitchell, their surveys and observations in regard to Edgartown and Nantucket, were submitted by the Board to its advisory council, consisting of Rear-Admiral C. H. Davis, Gen. A. A. Humphreys, Prof. Benj. Peirce and Prof. Henry Mitchell all of whom except Gen. Humphreys were able to give the subject their attention.

Their opinions were emphatically favorable to the practicability of restoring to Edgartown Harbor its former tidal circulation and to the national importance of the work, and expressed confidence that only benefit could result from an outlet through Haulover Beach.

These opinions are based upon studies of the localities in which these gentlemen have been personally engaged in years past as well as upon reports of recent operations of the Coast Survey undertaken at the request of this Board.

We have not hesitated, therefore, under the authority given us by the statute creating the Board to apply to Congress for an

appropriation for opening the outlet through Cotamy Beach for the preservation of Edgartown Harbor.

The memorial of the Board to Congress with the accompanying reports of Profs. Whiting and Mitchell to the Superintendent of the U. S. Coast Survey obligingly placed by him at our disposal, together with the opinion of the advisory council, are contained in the appendix.

WAREHAM RIVER.

Something was said, in the last annual report of the Board, on the subject of harbor lines and other improvements in Wareham River. Since the first survey of this river, made under the direction of the engineer of this Board, additional results have been obtained, through the courtesy of Gen. George Thom, of current observations and other data, from which, with the results of the survey of our engineer, a scheme of harbor lines has been devised. The map showing these lines and also some of the alternative plans of Gen. Thom for improving the river is appended.

Involved in the subject of the river improvement, or rather in the question of injury to its navigation, is that of the influence and effect of the structures of the Cape Cod Railroad and town bridges, which cross the river at what is called the "Narrows."

Through the kindness of Prof. Peirce, Superintendent of the Coast Survey, the Board has been furnished with a copy of the map and chart of this locality, executed by Coast Survey officers—Prof. H. L. Whiting and the late Com. G. S. Blake—in 1845, which affords an interesting and valuable comparison with the surveys just made by the Board, and shows marked changes in this portion of the river.

It can hardly be questioned that the construction of the solid pier between the west side of the river and the sluice-way or bay, through which scows and boats now pass, and the solid embankment of the Cape Cod Railroad on the west side of the river, together with the stone ballast which has been thrown around and between the piers of both the railroad and town bridges, have contributed mainly to the injury sustained, and have caused the violent and unequal currents which have dug out, as it were, the deep holes above, between, and below the bridges, and thrown up the abrupt and injurious shoals beyond them.

By Gen. Thom's survey, a difference of level or "head" was determined of 1.8 feet between the surface of the basin immediately above the bridges and the river just below them, which difference is undoubtedly caused by the contracted sections through the bridges, and by the "sills" or dams of stone along the bottom of these narrow, open sections. The solid stone pier forming the east abutment of the bridges is also a fruitful cause of the injurious effects produced.

From a careful study and examination, it is not apparent that the influence of these obstructions is felt beyond a local range,—about four hundred feet below the line of the town bridge being the extent or southern limit of the shoal or bar on the easterly side of the river. Below, or south, from this latter point, the river-bed assumes as even and good a depth (eleven feet at mean low water) as nature seems able to produce.

The injurious effects of the bridge structures, therefore, seem to be confined to about the first four hundred feet below them. There is no draw provided in either the town or railroad bridge, so that vessels with masts cannot pass beyond them. By certain stipulations, however, the grade of the railroad was fixed at a sufficient height to allow barges and scows to pass under the bridge as a substitute or equivalent for a draw, and these bridges have thus become essentially the head of the navigation of the river, and are not far from the point where nature would determine it if the bridges did not exist.

While there is no doubt that the physical condition of this upper portion of the river could be improved by the removal of the railroad embankment, the whole, or a part, of the solid pier near the centre of the river, the stone ballast from under each of the bridges, and the reconstruction of the railroad piers, it would be a measure of doubtful economy. It is the opinion of the Board that the river could be improved, and the improvement maintained, for a much less sum than it would take to remove and remodel the objectionable portions of the existing structures.

In connection with the establishment of harbor lines, the Board has had a public hearing in Wareham, duly advertised, at which the subject under consideration was discussed in general and in detail. A scheme of harbor lines has been devised,

which, although it covers a larger portion of the river than is demanded by its present commerce, is yet not too extensive for a comprehensive plan for the improvement and development of the port.

A plan showing these lines, and the form of an Act establishing them, together with the proposed project of improvement, are appended to this Report.

The importance of Wareham River to the large business interests established upon it has led to an application by the citizens of Wareham to Congress, to improve it for purposes of navigation. The application is strongly urged by those having it in charge, and it is to be hoped that it will prove successful. The case having been already reported favorably upon by the United States Engineer Department, the Board has not felt it necessary to interpose in its behalf.

GREEN HARBOR RIVER.

On the 29th day of November last, after visiting the ground, the Board located the dike across Green Harbor River, but a little below Turkey Point, in accordance with the application of the commissioners of the marsh-owners.

The county commissioners would have preferred to have the dike located further down the river, that it might have formed part of a projected county road from Cut River village along the shore above. The location adopted was selected by the commissioners of the marsh-owners, because of the lowness of the shore, and the slight barrier to the sea it presented at Brant Rock village, and the apprehension that in some storm the sea would make a breach through this low ground, inundate their reclaimed lands, and carry away their dike by the flood of waters behind it. By placing the dike further up the river than the proposed location for a county road, the dike will be out of the danger to be guarded against. These reasons were satisfactory and decisive of the question.

COMPENSATION FOR ATLANTIC AVENUE.

The assessment upon the city of Boston, for compensation for tide-water displaced by the construction of Atlantic Avenue, has not yet been paid, although often during the past year called to the attention of the municipal authorities.

The city delayed the payment in the year 1870, under the mistaken idea on the part of some members of its government, that the United States authorities, upon whose urgent advice the principle of compensation was applied to Boston Harbor by the State, had changed their opinions in regard to the necessity of the law. It accordingly petitioned the legislature of 1871 to be relieved from the assessment.

That there might be no possible misapprehension upon this point, the Board addressed a communication to its advisory council, made up, with one exception, of the same United States authorities, or their successors, upon whose recommendation this statute for the protection of Boston Harbor was originally passed. The correspondence is contained in the appendix, and shows the entire mistake upon which this action of the city council of 1870 was based.

This appears even more fully, if possible, in the evidence submitted at the hearing on this application, and appended to the able report of the Harbor Committee, in accordance with which the legislature gave the city leave to withdraw. (House Doc., No. 413, 1871.)

The Board had hoped that this action of the legislature would be loyally followed by the payment of the amount due into the treasury of the State. No appropriation, however, was made. Accordingly, on the 13th of November, 1871, the treasurer and receiver-general of the Commonwealth sent to the city government the following communication:—

To the Mayor and City Council of the City of Boston.

The treasurer and receiver-general of the Commonwealth of Massachusetts requests of the city of Boston the payment into the treasury of the Commonwealth of the amount due from the city under section 2 of chapter 324 of the Acts of the year 1867, entitled, "An Act to authorize the city of Boston to build a highway over certain tide-waters," which highway, since its construction, is called Atlantic Avenue.

The second section of this act is as follows:—"Such compensation shall be made for all displacement of tide-water, caused by anything done under this act, as the harbor commissioners shall determine, and made in the manner required by chapter 149 of the year 1866."

In accordance with the provisions of section 4, chapter 149, of statutes 1866, the Harbor Commissioners, on the 29th day of June, 1870, assessed this compensation at the sum of \$61,663.46, and under the law this sum is to be paid by the city into the treasury of the Commonwealth, to be held as part of the compensation fund for the benefit of Boston Harbor.

This sum has long been due, and its payment, with accrued interest, is respectfully demanded in behalf of the Commonwealth of Massachusetts.

CHARLES ADAMS, Jr.

The demand of the treasurer has not brought the payment. Whatever considerations may have led the last city government to dishonor this obligation to the treasury of the Commonwealth, the Board had hoped that no mistaken theories about Boston Harbor, no unfounded misapprehension or factious spirit would prompt the new city government just organized to defer longer the payment of this just debt. The law requiring this assessment was passed on the application of the city of Boston, made to the legislature on the advice of the United States Commissioners on Boston Harbor, investigating, in behalf of the city, what remedies should be adopted to prevent the harbor's deterioration. The provision for this compensation was especially incorporated into the Act authorizing the city to build Atlantic Avenue; it was assessed after notice to the city council that the city might be heard, and with the assent of the city solicitor as to its legality. The legislature has refused to relieve the city from it, and the money, when paid, will go into the treasury of the State, as a fund to be used for the benefit of Boston Harbor. Further delay in its payment is without a shadow of justification. The Board accordingly recommend the legislature to instruct the attorney-general to institute a suit for the collection of this debt of the city.

In connection with this subject, the Board suggest that some provision be made for the collection of assessments of this character, by suits in the name of the treasurer and receiver-general of the Commonwealth, prosecuted by the attorney-general. In cases where parties have displaced tide-water in Boston Harbor, lawfully under the authority of the legislature, the assessment could be collected by an action of contract; where they have done this in violation of the law, the amount

which would have been assessed, if the displacement had been lawfully made, should be collectable in an action of tort.

Other Compensation.

During the past year Malachi Clarke has paid \$75, and Messrs. Hosley & Russell have paid \$123.69 into the compensation fund for Boston Harbor.

THE BOSTON AND LOWELL RAILROAD COMPANY.

The Boston and Lowell Railroad Company, under chapter 291, statutes 1869, was authorized to widen its bridge across Charles River, or build a new one, not exceeding forty feet in width, to increase its terminal facilities in Boston.

The location and construction of the new structure were to be subject to the approval of this Board.

A plan which showed the contemplated structures seventy-four feet in width was left at the office, and the changes in it which the Board desired were communicated informally by its engineer. Accompanying the plans was a written description of the proposed new bridge, forty feet in width, and of a triangular piece, thirty-four feet in width, between the portion of the structure forty feet wide which the statute authorized, and the old passenger bridge, and adjacent to the old bridge, increasing the width of the whole bridge structure to seventy-four feet. The plans showed another triangular piece as not to be occupied, forty-one and one-half feet wide, between the new forty-foot bridge and the old bridge widened to sixty feet.

This description alleged that the first triangular piece was to be occupied, as shown on the plan, as part of the location of the road authorized under an Act of 1856. The statute being cited, and the parcel being described as within the location of the road, the Board, in the preliminary consideration of the plans, assumed that this statement was true, and that this additional tract was covered by a former grant. Before the plans had been redrawn to meet the views of the Board, the company applied for leave to begin the driving of piles to a very small extent in the lines it was arranged that they should be driven, for the purpose of obtaining room for the curve of a new track the company desired at once to lay down, promising to complete the plans in two days and return them for approval. The Board

did not consent to this, nor did it actually forbid anything to be done before the plans were approved. The company proceeded with its work, but the plans were not submitted.

The whole work, however, of building the bridge was then at once entered upon. The piles were driven upon the lines it had been understood they were to be driven upon and as the new plans to be drawn were to show them. But upon investigation the Board could not discover the grant or statute which authorized the occupation of the portion described as the triangular piece.

No statute of 1856 on the subject could be found. The only statute bearing upon the location which the road filed in 1856, was passed in 1853, and authorized a bridge only twenty-six feet wide, while the plans of the company showed an intention to occupy thirty-four feet more. The company had even occupied a width of one hundred and fifteen and one-half feet, where its plans showed an intention of occupying only to a width of seventy-four feet.

In the early part of September, the Board applied to the company for its plans, and for information as to the law under which it claimed to proceed as it was doing.

There was great reluctance on the part of the Board to stop work of such importance, and it still believed that the company must be acting under some law for the location of the road it had not been able to find. No information having been given in response to this application, the Board notified the company to appear and show by what authority it drove piles beyond the width of forty feet. The company finally appeared and presented its plans, but no authority could be shown for its action except chapter 387, statutes 1853, and chapter 291, statutes 1869, which together authorized an occupation sixty-six feet in width, while the space actually occupied has a width of one hundred and fifteen and one-half feet. There was no authority whatever for the appropriation of some twelve thousand square feet of this territory of the Commonwealth. So far from giving any notice to the Board of the character of its proposed action, it referred in its application to a statute as granting the requisite authority for occupying one portion, and represented by its plans that there was no intention to occupy the other portion of the territory it has unlawfully taken. The fact that no such

statute could be found made the citation only the more misleading. The Board disapproved the plans so far as they exceeded the width of forty feet authorized by law. Other plans were presented, with a notice of an intention to apply to the legislature to legalize the action of the company, and a protest against the Board's construction of the statute of 1869, because it claimed that a law authorizing a bridge to be built not exceeding forty feet in width, did not authorize it to be built to the width of one hundred and fifteen and one-half feet.

In consequence of this notice, the Board has suspended proceedings against the Boston and Lowell Railroad Company, to await the action of the legislature, if such an application shall be made, and no action has been taken upon the company's plans. If such an application having been made, should be granted, it should be granted upon such terms that it will be plainly understood that a lawless invasion like this of the public domain cannot be made with impunity.

WOODS' DAM.

The information of the Attorney-General *vs.* B. F. Woods, brought at the relation of the Board of Harbor Commissioners, to prevent the erection of a dam in Mystic River, has been brought to a final decision in the supreme judicial court, and that decision is in favor of the Commonwealth. The court sustained every one of the positions taken by the Board in relation to this structure. They were as follows:—

1st. That it was a structure unauthorized by the legislature, in tide-waters flowing into Boston Harbor, and so within the provision of section 5, chapter 149, statutes 1866.

2d. That it was an intrusion upon the bed of the stream, which is the property of the Commonwealth.

3d. That it obstructed the public right of boating on this river, which is a navigable stream.

GENERAL LAW.

In view of discussions in favor of general legislation, the Board has prepared and appended to this Report the form of a statute which will relieve the legislature of a class of applications involving no questions of principle, and which can all be brought under the operation of a general law.

These are the main features of the law proposed : —

First. The Board of Harbor Commissioners is authorized to license any occupation it may approve in tide-waters within the line of riparian ownership, and not outside of any harbor line.

Second. Outside the line of riparian ownership, and as far as to any harbor line, the Board is authorized to license occupation upon such terms as to consideration or otherwise as the governor and council shall approve. But this authority is not to apply to any shore along which a harbor line has not been established by law.

Third. Provision for recording all licenses and approved plans in the proper registry of deeds.

The powers here conferred, in regard to State flats on tide land, are less than were conferred upon the land agent by the Resolve (chap. 103) of 1859. This Resolve is still in force, but the office of land agent has been abolished, and his powers under this Resolve were transferred to the commissioners on public lands by chapter 85, 1861. Since the Board of Harbor Commissioners was established by chapter 149, statutes 1866, giving it jurisdiction of the tide lands, except those of the back bay, the commissioners on public lands have not considered that outside of the back bay they had any of the powers in regard to tide lands that were formerly in the land agent. Although the Harbor Commissioners have been invested with the jurisdiction of the land agent, his *powers* have not been conferred upon them.

The Resolve of 1859 is still in force unrepealed ; but there is no board that considers itself authorized to exercise what were the land agent's powers under this law in regard to State lands in tide-waters outside the back bay. What shall be the powers and duties of an administrative board is a purely legislative question, and this Board does not urge any enlargement of its functions. It only suggests that if a general law on these subjects is desired, the form of a law submitted will answer the purpose, although, in fact, it does little more than restore to vitality a law that already exists.

The Board has the facilities for the performance of these functions without increase of expense to the State.

FORMER RECOMMENDATIONS.

The Board would here again recommend the duplication by the State of the maps of the United States Coast Survey for the shores of Massachusetts, and penal legislation for the protection of harbors. These subjects were considered in the last annual report.

PLANS APPROVED.

The Board has approved plans, during the past year, for the erection of structures in or over tide-waters, as follows : —

For the construction of a bridge over the Merrimack River, between Haverhill and Groveland. Approved April 10, 1871.

For extending and widening a wharf in Gloucester by Amos A. Story. Approved March 1, 1871.

For the construction of a wharf in Taunton River, at Fall River, by the Mechanics' Mills Association, D. H. Dyer, Treasurer. Approved March 16, 1871.

For the driving of additional piles in draw No. 1, in Boston and Maine Railroad bridge. Approved March 18, 1871.

For the extension and widening of a wharf in Gloucester Harbor by Wm. Parsons. Approved April 2, 1871.

For the construction of five new wharves in Provincetown Harbor by Daniel Conway, Alfred Cook, John Atkins, N. P. Holmes, and N. E. Atwood. Approved June 23, 1871.

For the erection of a pile structure over a portion of a triangular piece of flats, situate at the Boston end of the Warren bridge, belonging to the Fitchburg Railroad Company. Approved July 8, 1871.

For the construction of a wharf at Falmouth Heights, Falmouth, by the Falmouth Heights Land and Wharf Company. Approved July 12, 1871.

For the construction of a wharf at Duxbury by the Duxbury Wharf Company. Approved July 21, 1871.

For the construction of a wharf in Provincetown Harbor by Benj. Lancy. Approved July 26, 1871.

For the extension of wharf in Charles River, at Old Cambridge, by the President and Fellows of Harvard College. Approved July 26, 1871.

For the construction of a wharf in Weymouth Fore River, Weymouth, by Henry Gardner. Approved August 2, 1871.

For the driving of extra piles in West Boston bridge by the city of Boston. Approved Sept. 6, 1871.

For the construction of a marine railway in Salem Harbor by Fisher & Perkins. Approved Sept. 13, 1871.

For filling solid a portion of Commercial Point bridge, Dorchester, by the city of Boston. Approved Sept. 28, 1871.

For the construction of a wharf at Wood's Hole, Falmouth, by the Cape Cod Railroad Company. Approved Nov. 1, 1871.

For an additional pile structure over a triangular piece of flats at the Boston end of the Warren bridge by the Fitchburg Railroad Company. Approved Nov. 25, 1871.

For the construction of a dyke across Green Harbor River, in the town of Marshfield. Approved Nov. 29, 1871.

In addition to the above matters considered and passed upon, the Board has had numerous hearings at its former office in City Hall, and at 8 Pemberton Square, and other places. Among them may be mentioned several hearings at their office concerning the establishment of modified harbor lines in South Bay.

Concerning the navigation and harbor lines of Fort Point Channel.

Concerning the structures of the Lowell Railroad Company.

Concerning the crossing of Mystic River in Medford.

Of mayor and citizens of Charlestown concerning the navigation of Charles River.

Of citizens of Marshfield, at Marshfield, concerning the dike across Green Harbor River.

Of citizens of Provincetown, at Provincetown, concerning harbor lines in Provincetown Harbor.

Of citizens of Edgartown, concerning the opening of Cotamy Beach.

Of citizens of Wareham, at Wareham, concerning harbor lines for Wareham River.

Of J. F. Wonson & Sons and Amos A. Story concerning wharf extensions in Gloucester Harbor.

On the removal of stones from Stony Beach in Hull.

On the application of Benj. Yancy to extend his wharf in Provincetown.

On the petition of Caleb Baker and others to prevent the removal of material from Scituate Harbor beaches.

On the extension of Charles S. Clark's wharf on South River, in Salem.

PURCHASES.

The Board has purchased, with the approval of the governor and council, two more of the four undivided sevenths of a parcel of flats in South Boston, the whole title to which it had not before been able to acquire. The parcel is situated on B Street extended, and the purchase is made under the authority of chapter 446, statutes 1869, and chapter 396, statutes 1871.

In making these purchases, the following two deeds were approved by the governor and council, and accepted by the Board:—

Joseph Cains to the Commonwealth, dated Dec. 31, 1870. Consideration, \$3,300.

Rebecca M. Riley to the Commonwealth, dated Dec. 31, 1870. Consideration, \$3,300.

FIELD WORK.

The field work executed by our engineer has had a wider range than heretofore, and has included harbors and waters of the Commonwealth of great importance. The special survey of Edgartown Harbor has been a part of his duty. In this the Board have taken part, but the work was done by order of the Superintendent of the United States Coast Survey.

A topographical resurvey was also made in connection with an elaborate hydrographic survey by Prof. Mitchell, of Vineyard Haven. The details of this work will be made the subject of future report.

These surveys, Edgartown and Vineyard Haven, occupied about two months of the midsummer, July and August.

Besides this work, a reconnoissance was made, in company with Prof. Mitchell, of the harbor of Nantucket, for the purpose of examining a project to cut through the beach at the "Haul-over," so called, at the eastern end of the harbor. As a result of this reconnoissance, Prof. Whiting reports that the scheme seems favorable, but that accurate surveys and examination of the ground should be made, in order to obtain more full physical data in regard to the nature of the beach and the action of the sea upon it, together with the waste of headlands in its vicinity. This will require a more favorable season than was available when the subject came up for consideration.

Still later a reconnoissance was made of Chatham Harbor, in company with the United States advisory council, Admiral Davis, Prof. Peirce, and Prof. Mitchell. Surveys of the locality of the new inlet which has broken open opposite the village of Chatham, together with such changes as it may occasion in other parts of the harbor, will be made hereafter, either by the Coast Survey or under the direction of the Board, and reported at a future time.

Additional surveys to those of last season were made at Wareham in connection with the work under the direction of Gen. Thom, in order to determine the tidal action in the river, and the peculiar flowage through the bridges.

In Boston Harbor an elaborate survey has been made, at the suggestion of wharf and ship owners of the city, of a part of the inner harbor and Fort Point Channel, lying off Long, Central, and India wharves, in order to ascertain what changes, if any, have taken place in the formation of the bottom within the last few years, and since the last surveys by Mr. Boschke in 1863. The result of the survey just made shows no material shoaling. In fact, at points where increased deposit was reported, the water was found to be as deep, and in some places deeper, than shown by the former survey. No local shoal, corresponding to a supposed deposit of sewage at or near the end of Central Wharf, could be discovered. Changes and deposits, however, may occur in short spaces of time, and such ground should be frequently examined.

A survey of Charles River, in front of the lands of Harvard College, has been made, for the purpose of defining the limit of wharf extensions.

An examination and subsequent survey of Mystic River were made in connection with the proposed construction of a new bridge over this river, between Medford and Somerville, above the Boston and Maine Railroad bridge.

An examination of the shores of Spectacle Island has been made in connection with a project for deepening the approaches to the landing on the southerly side of the island.

Also an examination of Deer Island, in connection with a project for grading the bluffs and constructing sea-walls.

Examination of ground in Winthrop for wharf extension.

Examination and sketch of ground on Weymouth Fore River for wharf extension of Henry Gardner.

A survey was made last winter, through the ice, of a ledge in Gloucester Harbor, for the purpose of determining new harbor lines, in order to give increased wharf facilities for large store-houses for salt for the extensive fish-packing business of Gloucester.

Also a survey, on the ice, in Gloucester Harbor, of disputed wharf rights and lines between Amos A. Story and J. F. Wonsen & Sons.

An examination and sketch of ground in Rockport for a proposed wharf and breakwater for the Pigeon Hill Granite Company.

Examination and sketch in Beverly for wharf extension of David Crowell.

A survey and examination of ground on Taunton River for wharf extensions at Somerset.

Examination and sketch of ground in Fall River for wharf extensions of the Mechanics' Mills Company.

Examination and sketch of ground in Duxbury for the purpose of location and construction of wharves of the Duxbury Wharf Company.

Examination and measurements in Provincetown Harbor for the purpose of locating wharf of Benj. Lewis and for determining boundary lines.

OFFICE WORK.

The following maps and plans have been prepared in the office, besides a large amount of miscellaneous work of which no special record has been kept :—

Four plans in connection with studies submitted in last report.

One original map of Wareham River.

One large plan of upper part of Wareham River for projecting harbor lines.

One reduced map of Wareham River to accompany report.

One large plan to illustrate scheme of improved water-ways in Boston Harbor.

One large plan illustrating scheme for improved terminal facilities for railroads on the north side of Boston.

One large map for Harbor and Railroad Commissioners.

Two large maps as studies for Harbor and Railroad Commissioners.

One copy of Fuller's Survey of South Bay.

One map showing comparison between the Des Barres and city maps of South Bay.

Three maps of South Bay showing different projects for modified harbor lines.

One map of Edgartown Harbor to accompany report.

One tracing of same for engraver's use.

One plan showing project for bridge across Charles River to accompany report.

One tracing of same for engraver's use.

Four plans showing projects for tunnels across Charles River and Fort Point Channel, to accompany report.

Four tracings of same for engraver's use.

One large sketch showing location of new bridge across Mystic River.

Five separate tracings of parts of Provincetown Harbor.

Office Work prepared for Legislative Committee on Harbors.

One sketch showing proposed wharf in Somerset.

One sketch showing change of harbor line in Gloucester Harbor in front of Parson's wharf.

One sketch showing location of new bridge across Mystic River near Auburn Street, Medford.

One sketch showing proposed wharf at Winthrop, Boston Harbor.

One sketch showing extension of Harris's Wharf, Boston Harbor.

One sketch showing a part of Nausset Harbor.

One sketch showing Harvard College wharf, Charles River, Cambridge.

One sketch showing location of proposed wharf in Weymouth Fore River, Weymouth.

One sketch showing calculations on South Boston flats.

One sketch showing proposed wharf in Beverly, Salem Harbor.

One sketch showing proposed new wharf and breakwater in Rockport.

One large map showing South Boston flats.

One map of a part of Provincetown Harbor.

CONCLUSION.

General J. G. Foster of the United States Engineers, on his departure from the State upon government service in the West last summer, terminated his relations with the Board. Mr. James M. Bugbee the efficient clerk of the committees of the City Council, upon the removal of the Board from City Hall to No. 8 Pemberton Square, Boston, resigned his place as clerk of the Commission which he had faithfully filled from its first organization. His duties are performed by a member of the Board. In other respects the organization of the Commission is the same as heretofore.

We are unwilling to conclude this Report without testifying our appreciation of the inestimable value of the United States Coast Survey, its vigilant watchfulness over the great interests in its charge, and the promptness with which its distinguished Superintendent answers the applications we make in behalf of the Commonwealth, with thorough investigations of the highest order, and the deductions they justify. With such aid, and the advice of the United States Advisory Council upon all questions involving physical problems the Board secures the highest scientific guarantee of a solid basis for its action.

JOSIAH QUINCY,
DARWIN E. WARE,
F. W. LINCOLN,
J. N. MARSHALL,
W. T. GRAMMER,

Board of Harbor Commissioners.

JANUARY 15, 1872.

South Boston Flats
LIGHT SEA WALL.

South Boston Flats
HEAVY SEA WALL.

EAST BOSTON

PLAN

for the occupation of

FLATS OWNED BY THE COMMONWEALTH

BOSTON HARBOR.

APPROVED AND ADOPTED BY THE GENERAL COURT.

By Chap. 81 of the Resolves of 1866
AND MODIFIED ACCORDING TO CHAP. 334 OF THE ACTS OF 1867
and Chap. 320 of the acts of 1868

SCALE 10000
Scale of Feet

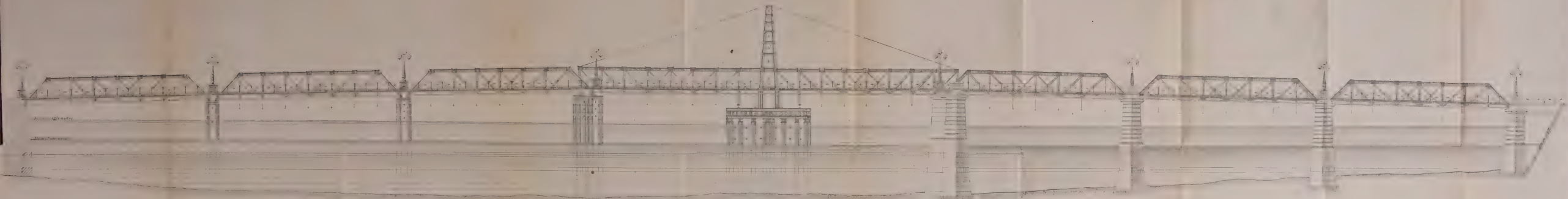
NOTE: The line between the flats and the harbor is shown by a dotted line.



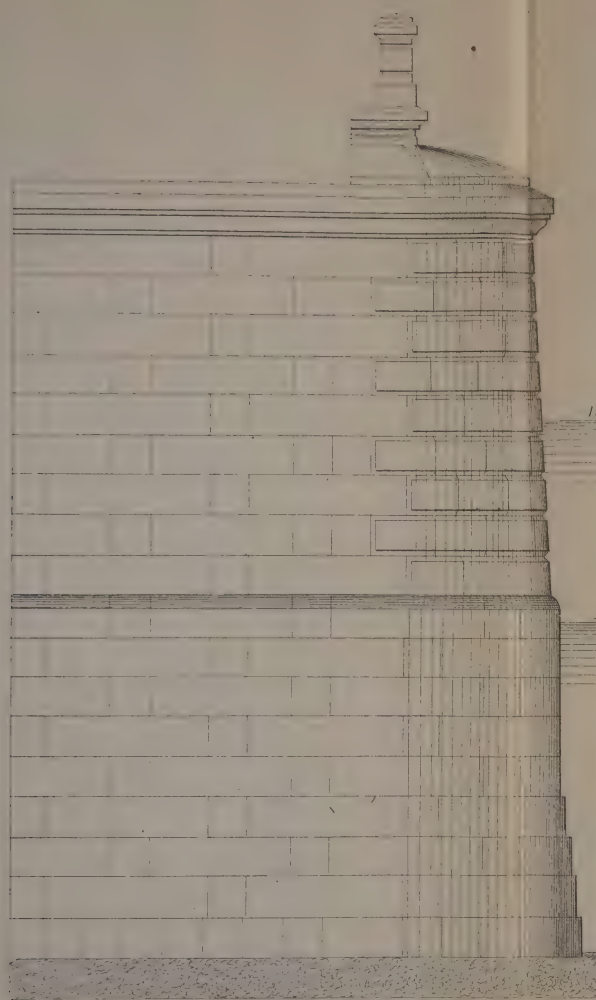


ELEVATION OF PROPOSED BRIDGE ACROSS CHARLES RIVER
TO CONNECT BOSTON AND CHARLESTOWN

Scale 20 feet = 1 in.





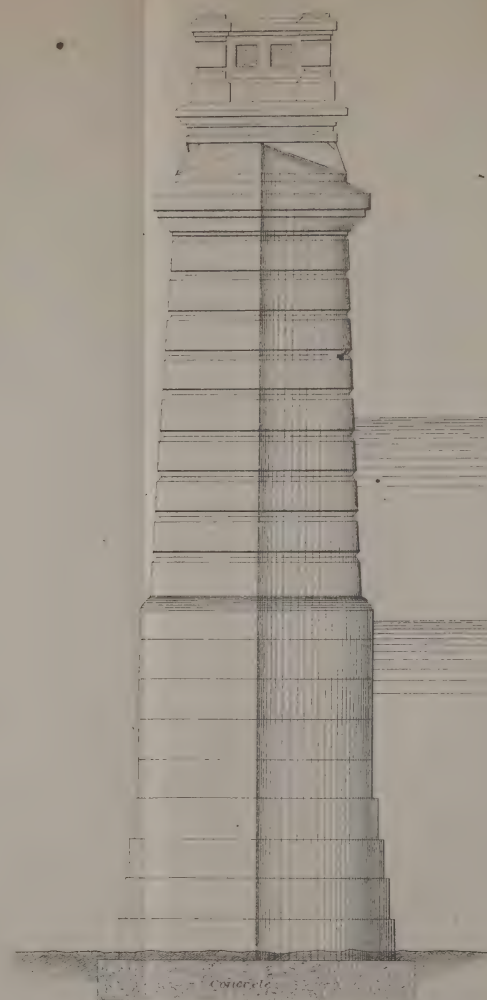


Part of Side Elevation.

High Water

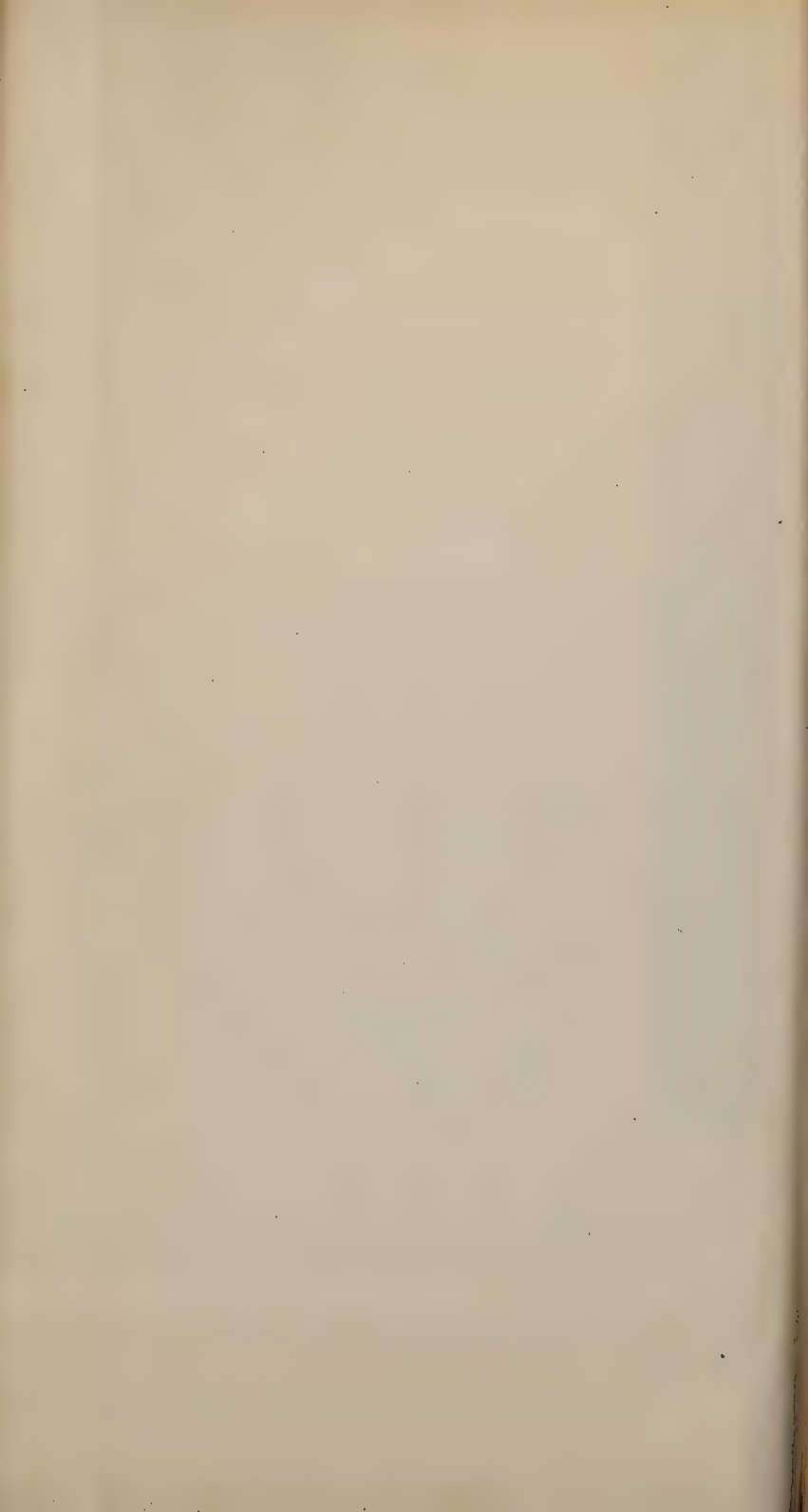
Low Water

Bottom



End Elevation

DETAILS OF STONE PIERS.



LONGITUDINAL SECTIONS OF TUNNELS.

C. WILKINS HARRIS

Fig. 1

LONGITUDINAL VERTICAL SECTION OF PROPOSED TUNNEL TO CONNECT BOSTON & CHARLESTOWN.

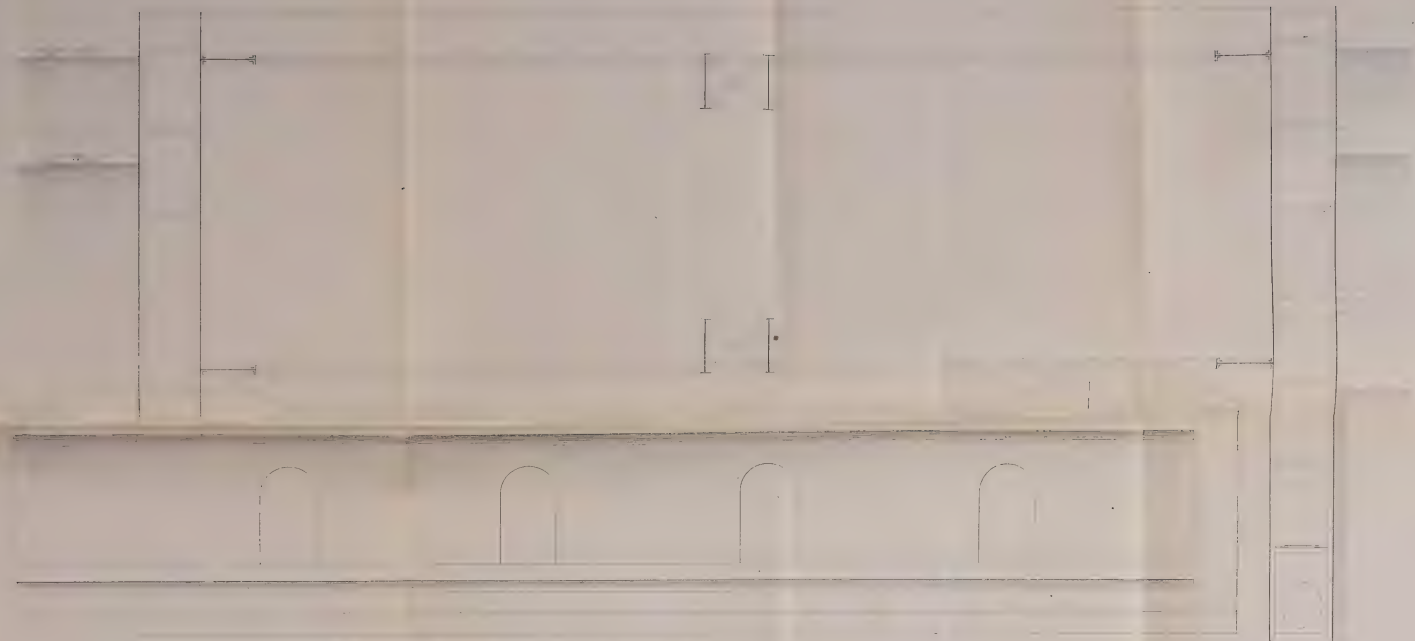
Fig. 2

LONGITUDINAL VERTICAL SECTION OF PROPOSED TUNNEL FROM FOOT OF SUMMER ST. TO SOUTH BOSTON.

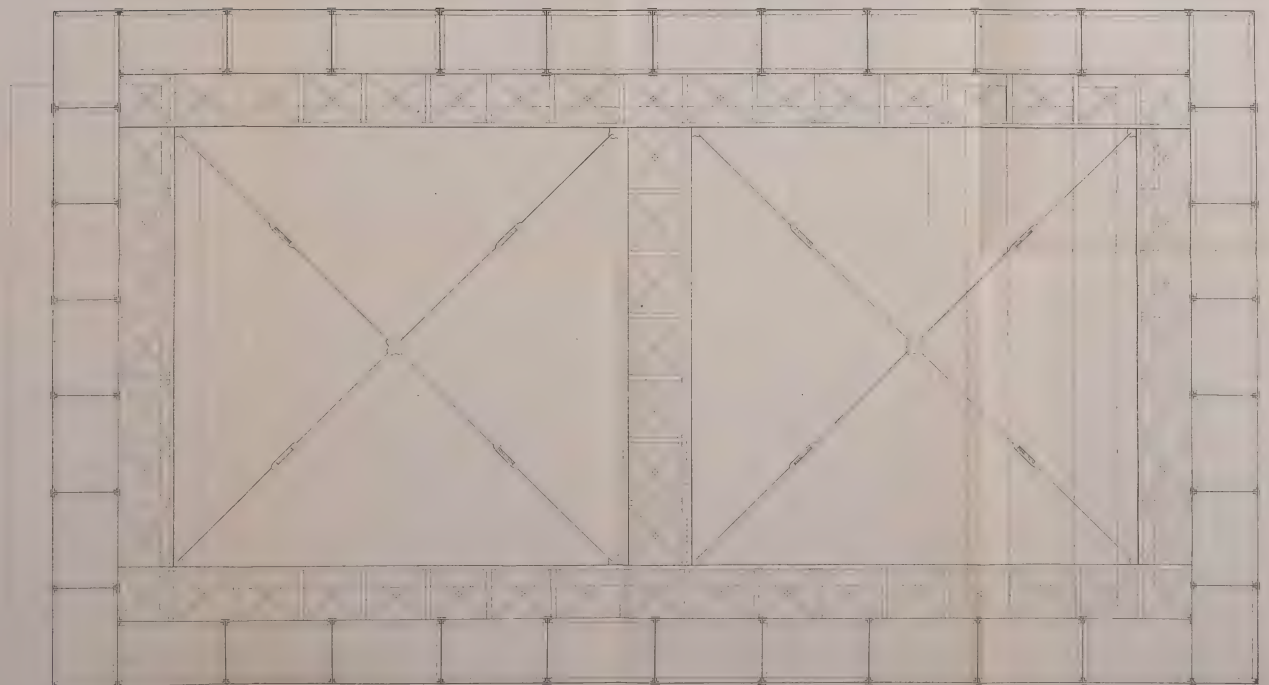
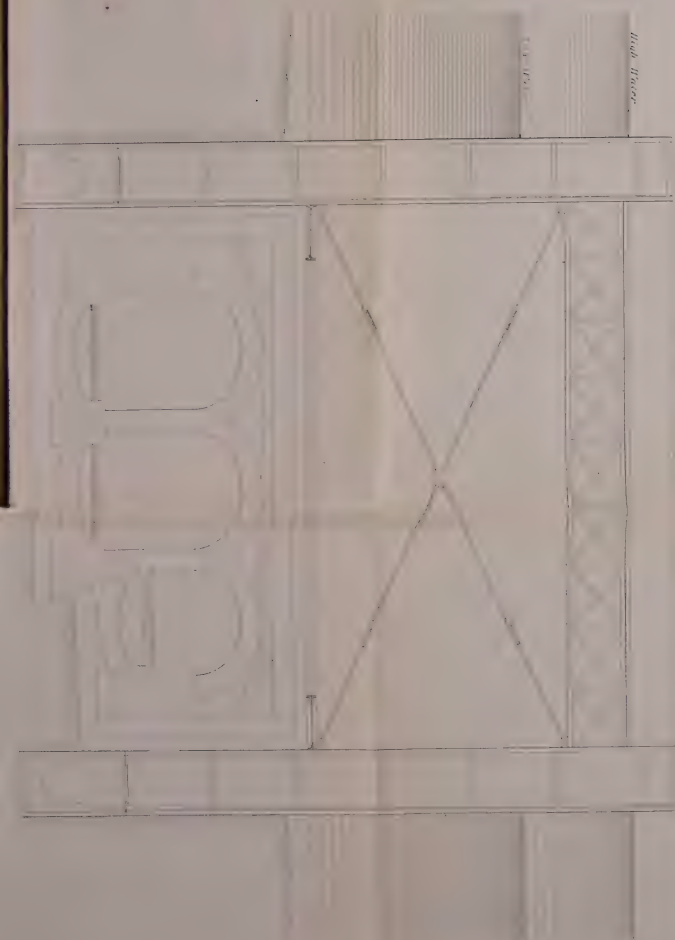
SECTIONS OF IRON COFFER-DAM.

Scale 8 in. = 1 ft.
Boston, Dec. 1874

CLEMENS HEISCHELL
Civil Engineer



LONGITUDINAL VERTICAL SECTION.



PLAN.





SECTIONS OF TUNNEL.

CLEMENS HIRSCHL
1880



U.S. COAST SURVEY
BENJAMIN PERCE, SUP.
SECTION I.
EDGARTOWN HARBOR AND COTAMY BAY,
MASS.

Topography by
H. L. WHITING, U.S.C.S.
Physical Hydrography by
H. MITCHELL and H. L. MAGINIS, U.S.C.S.
1871.

Scale 1:100,000

NOTE: The soundings are expressed in feet and are referred to
Mean Low Water.

The 3-foot surge is expressed thus
The 4-foot
The 5-foot
The 6-foot

P.M. The water table of Martha's Vineyard and Nantucket are
right hand of first steps, and B shows Mean Low Water.

WATER-WORN SECTIONS

Haulover-Nantucket

Mattakesett I.

Seituate.

Long Point

Cotamy Pt.

SECTIONS OF SOUTH BEACH.

II.

VI. Slue

IV.

VII. Slue

V.

III.

Scale of Sections 1:100,000 feet to 1 inch
1 foot to 1 inch

Section A.B.

Chappaquiddick Pt. to West Shore

Scale 1:100,000 feet to 1 inch
1 foot to 1 inch

TIDAL CURVES

Profile of Cotamy Beach
to Cotamy Bay

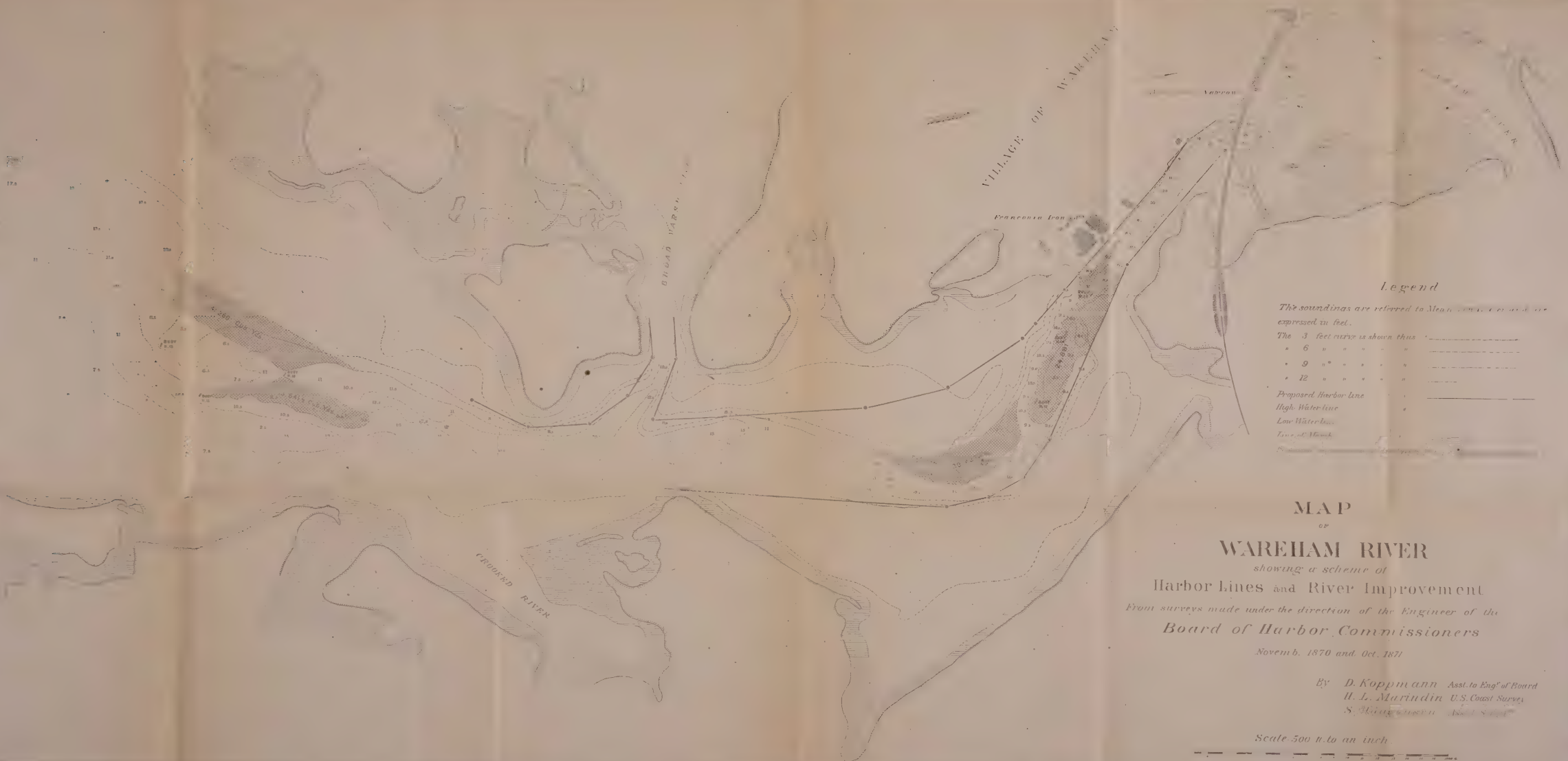
MATTAKESSETT BAY

Opening of 1850

Opening of 1840

1870

East Opening



Legend

The soundings are referred to Mean Low Water and are expressed in feet.

The 3 feet curve is shown thus

• 6	• 9	• 12
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Proposed Harbor line —————
High Water line - - - - -
Low Water line
Line of Beach ————

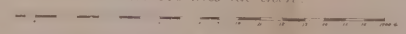
MAP
OF

WAREHAM RIVER

showing a scheme of
Harbor Lines and River Improvement
From surveys made under the direction of the Engineer of the
Board of Harbor Commissioners
November, 1870 and Oct. 1871

By **D. Koppmann** *Asst. to Eng' of Board*
H. L. Marindin *U.S. Coast Survey*
S. Wingerson *Asst. Surveyor*

Scale 500 ft. to an inch





A P P E N D I X .

APPENDIX.

BOSTON, HARTFORD & ERIE RAILROAD, OFFICE OF THE TRUSTEES, }
40 STATE STREET (Room 20), BOSTON, January 9, 1872. }

Hon. JOSIAH QUINCY, *Chairman of the Board of Harbor Commissioners.*

SIR:—The recent sale by auction of the flats conveyed to Messrs. Harvey, Whitney and Groves, trustees, by the Commonwealth, for a default in the conditions of the mortgage given by them to secure the purchase money, and your duty in accordance with a resolve of the legislature to recommend some plan as to these flats, furnish both the occasion and our apology for addressing you briefly as to the real situation of the property which has fallen into our possession as the representatives of the bondholders and mortgage creditors of the Boston, Hartford and Erie Railroad Company.

We assume that you are aware, that, in addition to the parcel of flats mentioned above, another large tract of lands and flats, purchased by the Boston, Hartford and Erie Railroad Company for like purposes, and likewise conveyed to Messrs. Harvey, Whitney and Groves, and upon which now stand the temporary structures of the company in use as engine, car and machine shops, and adjoining the parcel mentioned above, has also been sold under proceedings to foreclose the mortgage for the purchase money in favor of the Boston Wharf Company, of whom this parcel was bought.

As trustees under the mortgage made by the Boston, Hartford and Erie Railroad Company to Robert H. Berdell and others, March 19, 1866 (known as the "Berdell mortgage"), we have taken possession of the property covered by said mortgage for default, and for the purpose of foreclosure; and it is hoped and expected that the foreclosure will become complete, and the absolute title to the mortgaged property vested in the bondholders under said mortgage, in a few months.

The Berdell mortgage covers the entire railway and rolling-stock and much of the other property of the company. Without advert-ing now to the legal question, whether it applied as a second mortgage to either of the parcels of land held by Messrs. Harvey, Whitney and Groves, and sold, as above mentioned, by the Common-

weath and by the Boston Wharf Company to foreclose their first and prior mortgages, it is sufficient to say that these mortgages to the Commonwealth and to the Boston Wharf Company were such in amount as the trustees under the Berdell mortgage could not by any possibility pay. Nothing of consequence was paid by the Boston Hartford and Erie Railroad Company toward these purchases. Substantially the whole amount of the purchase-money with accumulated interest remained to be paid, and the mortgage, upon the parcel sold by the Commonwealth, secured the entire State loan to the company in addition. Thus these purchases of lands for terminal purposes amounted to little more than engagements securing a right to obtain the lands by paying the entire purchase-money, the interest and the Massachusetts State loan to the corporation.*

While, therefore, it would seem that the managers of the Boston, Hartford and Erie Railroad had commendable foresight in regard to the amount of land which would be required for the future wants of the road, it is most unfortunate for us, their successors, to find that no absolute title was acquired by them to a single foot of land for terminal purposes in South Boston, outside the location of the railroad.

So that the trustees, upon coming into office, found themselves at the head of a railroad interest, embracing in actual use and partially constructed, about four hundred miles of road, with no land for shops or depot accommodation outside the track location, at its most important terminus.

Under these circumstances, the trustees do but act under a sense of their official duty when they respectfully remonstrate against any disposal of the flats which have now, by the recent foreclosure, come into possession of the Commonwealth, that shall place it out of the power of the bondholders, whom they represent, to avail themselves of this property as soon as their title to the property of the

* The mortgage, Harvey *et al.*, to the Boston Wharf Company, secures the note of the B., H. & E. R. R. Co. for \$150,000, with interest. Date, November 20, 1868. Accompanying this mortgage, is an agreement providing that the B., H. & E. R. R. Co., may, within a certain time, relieve themselves from paying this note by filling and building part of a certain highway (Eastern Avenue).

The mortgage, Harvey *et al.*, to Trustees for the Boston Wharf Company, secures the payment of the bonds of the B., H. & E. R. R., to the amount of \$1,200,000, with interest at 7 per cent. Date, November 20, 1868.

The mortgage, Harvey *et al.*, to the Commonwealth (being a first mortgage upon the lands sold by the Commonwealth, and also a second mortgage upon the Boston Wharf property) secures the payment of note of B., H. & E. R. R. Co. for \$545,505, with interest at 6 per cent., and also the repayment to the Commonwealth of all the State scrip which the B., H. & E. R. R. has received or may receive under the statutes in aid of the road. Date, July 21, 1869.

Boston, Hartford and Erie Railroad mortgaged to them shall become absolute. As soon as this shall take place, these bondholders will become, according to the terms of the mortgage, a new corporation, with all the powers of a corporation, instead of the limited powers of trustees; they will be the absolute owners of all the property covered by the Berdell mortgage; their mortgage title will become a complete title; and it cannot be doubted that they will both be able to complete the road, and also that, with the road completed, lands in Boston for depot and terminal purposes, such as those in question, will not only be needed, but will be indispensable.

We should be glad to see the work of improvement as to these flats go on, and believe that our unwillingness to see the property pass into other hands does not interfere with a comprehensive plan for their development. Our powers and resources do not enable us to purchase this property, but we believe they may enable us to rent it until such time as the new corporation to be formed by the bondholders can act, if the plan to be adopted is such that the Commonwealth would fill the land.

The Commonwealth has in this matter a twofold interest. It is, in the first place, the owner of nearly one-fifth of the Berdell bonds. Upon the completion of the foreclosure it will be the owner of the like proportion of the entire road and property; that is, it will become a stockholder, holding nearly one-fifth of the stock in the new corporation. It has, in the second place, that higher interest with which the State must ever cherish works of public importance. A consideration of the public importance to Massachusetts and to Boston of this railroad induced the State loan in the beginning. The public importance of this road was the cause of the loan which is now to make the State a stockholder. While the public interest of the State is certainly greater than any private or pecuniary interest can be, its pecuniary interest is identical with that of every other bondholder. Indeed, in thus speaking, we speak as much for the State as for any other.

During the short time the property of this railroad has been in the hands of its creditors; with all the embarrassments, limitations and want of power incident to the situation, something has been done toward completing and equipping the road. The work of grading the division between Putnam and Willimantic—a distance of twenty-six miles—has slowly but steadily progressed; the iron rails for this division have been bought and laid; and though the work is not completed, it is now so far completed that trains can be run from one end of the division to the other. Bridges and other structures deemed insufficient have been replaced by those of a more

thorough character; considerable rolling-stock has been purchased; and the trustees have endeavored to apply all the money at their disposal as judiciously as possible toward the substantial improvement, completion and equipment of the road.

Under these circumstances, we confidently believe that your honorable board will, in the development of the flats, which you shall mature and recommend to the legislature, preserve for the new corporation which is to arise from these bonds, the property heretofore selected and so well adapted for terminal grounds for this railroad, and will not by any act of yours suffer it to be alienated to other and different interests. We count upon your forbearance, not toward the Boston, Hartford and Erie Railroad Company, but toward its creditors, whom alone we represent, and of whom the State is one, and the largest. We trust and believe that those creditors are at no distant day to become a strong, a vigorous and an honest corporation, managing a valuable railroad, a credit to themselves, an honor to the State and an incalculable benefit to the commerce of the harbor of Boston.

Respectfully, your ob't servants,

WM. T. HART,
GEO. TALBOT OLYPHANT,
CHARLES P. CLARK,

Trustees.

BOSTON, Jan. 13, 1872.

HON. JOSIAH QUINCY, *Chairman of Harbor Commission.*

SIR:—In complying with your request, I have the honor to report that I have examined, quite minutely, the subject of bridges over waters surrounding Boston, and herewith submit a plan for an iron bridge, which is designed especially to connect Boston and Charlestown. I am satisfied that bridges of this description and of sufficient strength to support the heaviest traffic can be built, at the various points, and of the required dimensions, to cross any of the waters surrounding Boston for the average cost,—

For each square foot of superstructure, . . .	\$5 00
Piers, per " " " . . .	2 00
<hr/>	
Total,	\$7 00

The bridge to be built entirely of iron, and furnished with wood pavement and power to operate the draw. This does not cover

the abutments, fender piers, or the slight amount of grading necessary to obtain sufficient height to allow tow-boats to pass under.

Wherever a sufficient pressure can be obtained from the city water-pipes I would recommend the use of water-engines for motive-power.

From my experience with, and observation of, some of the largest pivot drawbridges in the world, I have no hesitation in saying that, in my judgment, this draw would open or close in one minute.

Very respectfully,

E. H. HEWINS, *Civil Engineer.*

ESTIMATE of the cost of 3 piers, a draw pier and again 3 piers, of the following heights, respectively:—

Piers to be for a bridge 100 feet wide, . . .	{ 46 feet.
	{ 50 "
Draw pier 45 feet in diameter,	{ 56 "
	{ 40 "
Piers to be for a bridge 100 feet wide, . . .	{ 50 "
	{ 43 "
	{ 35 "

For a bridge between Boston and Charlestown—

The draw-pier is supposed to have a thickness of 8 feet; that is to say, is supposed to be a ring in cross-section, 45 feet external and 29 feet internal diameter. For remaining dimensions of the piers, see the drawing which accompanies this estimate.

In the six piers there are about . . . 12,342 cubic yards.

In the draw-pier there are about . . . 1,592 " "

13,934 cubic yards.

Cut stone above water and "bed and build" stone below water, laid by divers, will each cost about \$20 per cubic yard.

13,934 cubic yards at \$20, \$278,680 00

Or say, \$300,000 00

CLEMENS HERSCHEL, *Civil Engineer.*

ESTIMATE of the Cost of Building a Tunnel, from the foot of Summer Street to South Boston.

1. Land and damages,	\$30,000 00
2. Excavation in the approaches, 14,660 cub. yds.,	
3. " " shore tunnels, 42,800 "	

	57,460 cub. yds., @ \$1.50,	86,190 00
4. " " river tunnel, 19,444 "	@ 2.00,	38,888 00
5. Back filling and puddling,		22,500 00
6. Retaining walls, masonry, . . . 5,890 cub. yds., @ 15.00,		88,350 00

Shore Tunnel,—

7. Brick masonry, in cement, 12,234 cub. yds., @		
\$15,	\$183,510 00	
8. Stone foundation blocks, 1,288 cub. yds., @		
\$20,	25,760 00	
9. Concrete, 4,785 cub yds, @ 33 $\frac{1}{2}$ cts., . . .	1,595 00	
		210,865 00

River Tunnel,—

10. Brick masonry, in cement, 6,635 cub. yds., @		
\$15,	\$99,525 00	
11. Stone foundation blocks, 505 cub. yds., @ \$20,	10,100 00	
12. Concrete, 1,985 cub. yds., @ 33 $\frac{1}{2}$ cts., . . .	662 00	
13. Flagging, 2,580 sq. yds., @ \$9,	23,220 00	
14. Asphalt and brick laid in asphalt, 4,400 sq.		
yds., @ \$1,	4,440 00	
		137,947 00
15. Wood pavement, total, 5,678 sq. yds., @ \$4.50, . . .	25,551 00	
16. Timber sidewalk, total, 50,000 ft. B. M., @ \$30, . . .	1,500 00	
17. Brick sewer, drain-pipes, well, &c,	6,850 00	
18. Wrought-iron fence at approaches, 1,950 ft., @ \$4, . . .	7,800 00	
19. Gas pipes and fixtures,	1,500 00	
20. Stone entrance houses, steps and platforms,	6,000 00	

Coffer-Dam,—

21. Sheet piling and timber, 245,000 ft. B. M., @		
\$30,	\$7,350 00	
22. Sheet piling driven, 2,720 ft. lineal, @ \$1.25,	3,400 00	
23. Iron rods, bolts, &c.,	2,500 00	
24. Puddling, 43,521 cub. yds., @ \$1.10,	47,873 00	
25. Pumping, 300 days, @ \$30,	9,000 00	
		70,123 00

	\$734,064 00
10 per cent. for contingencies and omissions,	73,406 00
Engineering and superintendence, &c,	75,000 00

Grand Total, \$882,470 00

ESTIMATE of the Cost of Building a Tunnel 32' wide, from Charlestown to Boston.

1. Land and damages,	\$60,000 00
2. Excavation in the approaches, 20,354 cub. yds.,	
3. " " shore tunnels, 87,400 "	
<hr/>	
	107,754 cub. yds., @ \$1.50, 161,631 00
4. " " river tunnel, 39,000 "	@ 2.50, 97,500 00
5. Back filling and puddling,	35,000 00
6. Retaining walls, masonry,	7,848 cub. yds, @ 15 00, 117,720 00
<hr/>	
Shore Tunnel,—	
7. Brick masonry, in cement, 24,804 cub. yds.,	
@ \$15,	\$372,060 00
8. Stone foundation blocks, 2,522 cub. yds. @	
\$20,	50,440 00
9. Concrete, 9,210 cub. yds., @ 33 $\frac{1}{2}$ cts., . . .	3,070 00
<hr/>	
	425,570 00
River Tunnel,—	
10. Brick masonry, in cement, 13,270 cub. yds.,	
@ \$15,	\$199,050 00
11. Stone foundation blocks, 1,010 cub. yds, @	
\$20,	20,200 00
12. Concrete, 3,970 cub. yds, @ 33 $\frac{1}{2}$ cts., . . .	1,323 00
13. Flagging, 5,160 sq. yds., @ \$9,	46,440 00
14. Asphalt and brick laid in asphalt, 8,880 sq. yds ,	
@ \$1,	8,880 00
<hr/>	
	275,893 00
15. Wood pavement, total, 10,183 sq. yds., @ \$4.50,	45,824 00
16. Timber sidewalk, 75,000 ft. B. M., @ \$30,	2,250 00
17. Brick sewer, drain-pipes, well, &c,	9,900 00
18. Wrought-iron fence at approaches, 2,600 ft lineal, @ \$4, . . .	10,400 00
19. Gas pipes and fixtures,	2,000 00
20. Stone entrance houses, steps and platforms,	6,000 00
<hr/>	
	\$1,249,688 00
10 per cent. for contingencies and omissions,	124,969 00
Engineering and superintendence, &c.,	125,000 00
<hr/>	
	\$1,499,657 00
Add cost of coffer-dam, and cost of using same, as on page	
91,	263,175 00
<hr/>	
Grand Total,	\$1,762,832 00

ESTIMATE of the Cost of Building a Tunnel 64' wide, from Charlestown to Boston.

1. Land and damages,	\$60,000 00
2. Excavation in the approaches, 32,354 cub. yds.	
3. " " shore tunnels, 155,400 " "	
	<hr/>
	187,754 cub. yds., @ \$1.50, 281,631 00
4. " " river tunnel, 78,000 " @ 2.50,	195,000 00
5. Back filling and puddling,	50,000 00
6. Retaining walls, masonry, 7,848 cub. yds., @ \$15, . . .	117,720 00
Shore Tunnel,—	
7. Brick masonry, in cement, 44,108 cub. yds.,	
@ \$15,	\$661,620 00
8. Stone foundation blocks, 4,311 cub. yds., @	
\$20,	86,220 00
9. Concrete, 17,606 cub. yds., @ 33½ cts., . . .	5,869 00
	<hr/>
	753,709 00
River Tunnel,—	
10. Brick masonry, in cement, 26,540 cub. yds.,	
@ \$15,	\$398,100 00
11. Stone foundation blocks, 2,020 cub. yds, @	
\$20,	40,400 00
12. Concrete, 7,940 cub yds., @ 33½ cts., . . .	2,646 00
13. Flagging, 10,320 sq. yds, @ \$9,	92,880 00
14. Asphalt and brick laid in asphalt, 17,760 sq.	
yds., @ \$1,	17,760 00
	<hr/>
	551,786 00
15. Wood pavement, total, 20,366 sq. yds, @ \$4.50, . . .	91,648 00
16. Timber sidewalk, 150,000 ft. B. M., @ \$30, . . .	4,500 00
17. Brick sewer, drain-pipes, well, &c.,	19,800 00
18. Wrought-iron fence at approaches, 2,600', lineal, @ \$4, .	10,400 00
19. Gas pipes and fixtures,	4,000 00
20. Stone entrance houses, steps and platforms,	12,000 00
	<hr/>
	\$2,152,194 00
10 per cent. for contingencies and omissions,	215,219 00
Engineering, superintendence, &c.,	200,000 00
	<hr/>
	\$2,567,413 00
Add cost of coffer-dam, and cost of using same, as on page	
91,	412,005 00
	<hr/>
Grand Total,	\$2,979,418 00

ESTIMATE of the Cost of an Iron Coffe-Dam, as shown on Plan 8, and of using same for the Construction of the Charlestown Tunnels.

[The estimate of the cost of the coffer-dam was made for undersigned by a builder of iron ships, floating dry docks, and other work of same nature, and calculated for a depth of water of 60 ft. C. H.]

Displacement per foot in depth,	1,944 sq. ft.
Cubic displacement per foot in depth, . . .	124,417 lbs.
Draught of coffer-dam, not weighted, . . .	about 9½ ft.
External dimensions, . . . 112' long × 62' wide × 60' high.	
Internal " . . . 100' " × 50' " × 60' "	

	lbs.
Side-plating [$\frac{5}{16}$ " av'ge], 38,880 sq. ft., @ 13 lbs.,	505,440
Longitudinal T iron, 24,000 ft., @ 12 lbs.,	288,000
Vertical angle iron, 6,480 ft., @ 8 lbs,	51,840
Rivets and straps to above,	61,000
Bulkhead plating, 12,240 sq. ft., @ 10 lbs,	122,400
Butt straps and rivets, 4,080 ft., @ 4 lbs. and rivets,	22,320
Deck plating, . . . 1,944 sq. ft., @ 10 lbs.,	19,440
Angle iron, under deck, 960 ft, @ 8 lbs.,	7,680
Rivets,	400
Tension rods, . . 500 ft., 1½" diam., @ 4 lbs,	2,000
" " . . 556 ft. 1" " @ 4 lbs,	1,500
Strap iron, . . . 6" × ¼", 700 ft., @ 5 lbs,	3,500
Angle iron, . . . 3" × 3", 1,608 ft., @ 8 lbs,	12,864
Rivets,	1,200
Add	416

1,100,000

Add 5 per cent. for omissions, 55,000

Total weight, 1,155,000
9

Cost, delivered, 9 cts. per lb, \$103,950 00 \$103,950 00

Using coffer-dam once,—

Excavation, in pneumatic chambers, 1,440 cub. yds, @ \$5,	\$7,200 00
Pumping and compressed air during building of tunnel, 60 days, @ \$60,	3,600 00
Driving about 105 fender piles, @ \$5 and fenders,	1,000 00
Raising coffer-dam and removing,	500 00

Cost of using coffer-dam once, \$12,300 00
11

Cost of using coffer-dam 11 times, 135,300 00

Cost of building tunnel 32 ft. wide with coffer-dam, . . .	\$239,250 00
10 per cent. for contingencies,	23,925 00
	<hr/>
To be added to estimate of tunnel 32 ft. wide,	\$263,175 00
	<hr/>
Cost of using coffer-dam 22 times, @ \$12,300,	\$270,600 00
Cost of iron coffer-dam,	103,950 00
	<hr/>
	\$374,550 00
10 per cent. for contingencies,	37,455 00
	<hr/>
To be added to estimate of tunnel 64 ft. wide,	\$412,005 00
	<hr/>

Value of coffer-dam after work is completed, \$60,000 to \$70,000, which is not deducted in above estimates.

CLEMENS HERSCHEL, *Civil Engineer.*

REPORT OF GEN. GEORGE THOM TO GEN. A. A. HUMPHREYS, CHIEF OF U. S. ENGINEERS.

U. S. ENGINEER OFFICE, BOSTON, MASS., January 6. 1872.

Brig. Gen. A. A. HUMPHREYS, *Chief of Engineers, United States Army, Washington, D. C.*

GENERAL :—I have the honor to submit the following report of operations during the six months ending December 31, 1871, for the improvement of the several harbors and rivers under my charge, in the State of Massachusetts, viz. :—

I. BOSTON HARBOR.

The several contemplated works now in progress, for the preservation and improvement of this harbor are the following, viz. :—

1. The sea-wall, for the protection and preservation of Point Allerton.
2. The sea-wall, for the protection and preservation of Gallop's Island.
3. The sea-wall, for the protection and preservation of Long Island Head.
4. The completion of the removal of Kelly's Rock; and
5. Deepening the channel by dredging through the Upper Middle Bar.

Sea-Wall on Point Allerton.

Work upon this wall was commenced in September, 1870, under a contract made May 24, 1870, with Mr. James M. Andrews; and was carried on under that contract until the first of June, 1871; when the appropriation, under which the contract was made was exhausted. The work was thence continued, under the new appropriation of March 3, 1871, with hired labor and machinery, until the 20th of August; and, since then, under a contract made the 26th of July, 1871, with Mr. James M. Andrews, the former contractor.

During the past six months the following work has been done. Granite facing, with concrete foundation and backing laid, an average of 219 linear feet; granite coping laid 439 linear feet; leaving to be done, in order to complete the wall to its contemplated length of 1,230 feet, an average of 541 linear feet of wall (including concrete foundation, backing and coping) to be laid; about 5,100 cubic yards of earth to be moved and placed as back filling and on the slopes of the bluff in rear; and 2,050 superficial yards of paving to be laid behind the wall.

Sea-Wall on Gallop's Island.

Work upon this wall was commenced in the year 1868, under a contract made May 26, 1868, with Mr. James Andrews, of Biddeford, Me., and was carried on under that contract until the end of April, 1871; and since then, with hired labor and machinery, up to the latter part of September.

The progress made during the past six months is as follows, viz.: 1,140 superficial yards of granite paving has been laid; 51 cubic yards of dry wall built to connect the eastern end of the sea-wall with the bank in its rear; and about 300 cubic yards back filling placed; whereby the whole sea-wall has been completed to its contemplated length of 1,745 feet; there remaining only about 5,000 cubic yards of grading to be done on the bluff in its rear.

Sea-Wall on Long Island.

The construction of this wall was commenced in August, 1870, by Mr. James Andrews, under a contract made May 24, 1870, and work was carried on under that contract until the 1st of June, 1871, when the appropriation, under which the contract was made, became exhausted. The work was then continued, under the appropriation of March 3, 1871, with hired labor and machinery, until the 21st of August; and, since then, under a contract made July 26, 1871, with Mr. James Andrews, the former contractor.

During the six months ending December 31, 1871, the following work has been done upon this sea-wall, viz. :—granite facing, with concrete foundation and backing laid, an average of 498 linear feet; granite coping 798 linear feet; and about 2,500 cubic yards of back filling placed, which leaves to be done, in order to complete the wall to its contemplated length of 2,100 feet, an average of 863 linear feet of wall (including concrete foundation, backing and coping) to be laid; about 5,400 cubic yards of back filling and grading to be done; 3,460 superficial yards of granite paving to be laid; and 50 cubic yards of dry wall to be built, in order to connect the south-eastern end of the wall, with the bank in its rear.

Kelly's Rock.

In 1869 and 1870, this rock was broken up and removed, to a depth of 23 feet at mean low water, with the exception of a few projecting points, which still have but $21\frac{1}{2}$ of water upon them.

Upper Middle Bar.

The contemplated plan for the improvement of this bar, consists in the excavation of a channel through it to a width of 600 feet, and to a depth of 23 feet at mean low water. From surveys recently made, it appears that the average length of the projected cut is 2,200 feet; and that the depth of the excavation will vary from one to seven feet. This will require the excavation of about 250,000 cubic yards, in addition to that already dredged.

Under a contract made May 24, 1870, with Mr. Emory R. Seward, of Albany, N. Y., dredging was carried on at this bar until the 1st of June, 1871, when the appropriation under which the contract was made, became exhausted—26,120 cubic yards having been removed under that contract, whereby one cut was opened nearly through the bar to a width of 45 feet, and to a depth of from 20 to 23 feet at mean low water; some progress was also made on a second cut.

Under instructions from the department, proposals were again invited for continuing this work by contract, under the new appropriation of March 3, 1871; and a contract was made July 29, 1871, with Mr. R. G. Packard, of Brooklyn, N. Y. (who was the lowest of five bidders) for doing this work at 57 cents per cubic yard, the work contracted for to be completed on or before the 30th of June, 1872. The quantity to be dredged under this contract, is not to exceed 40,000 cubic yards; whereby (with the dredging already done) a channel of 150 feet in width will be obtained, with a depth of 23 feet at mean low water. In the early part of December, Mr.

Packard commenced operations with his dredging machine; but, on account of the weather found it impracticable to continue work, which was accordingly suspended till spring.

The balance of the appropriation, available for the improvement of Boston Harbor, July 1, 1871, was \$78,644.17. Amount available therefor, January 1, 1872 (excluding retained percentage and other outstanding liabilities), is \$18,835.63, the most of which it is contemplated to apply to the dredging on the Upper Middle Bar.

II. MERRIMACK RIVER, MASSACHUSETTS.

The following works were originally contemplated for the improvement of this river, viz. :—

1. The removal of obstructions at the Upper and Lower Falls, above Haverhill, Mass.
2. The removal of Gangway Rocks, in Newburyport Harbor, Mass.
3. The removal of "The Boilers" near the city wharves at Newburyport.
4. The removal of the wreck of the schooner *Globe*, a coal vessel sunk at the mouth of the river near Newburyport Light.

By Act of Congress of July 11, 1870, there was appropriated therefor	\$25,000 00
And by Act of March 3, 1871,	25,000 00
Total	<hr/> \$50,000 00

Amount expended during the fiscal year, ending June 30, 1871,	24,996 34
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Amount available July 1, 1871,	<hr/> \$25,003 66
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With the amount expended by my predecessor (Gen. Foster) upon the above works in the fiscal year ending June 30, 1871, progress was made as follows, viz. :—

1. The main Gangway Rock was broken up and removed to a depth of nine and one-half feet at mean low water; and a commencement made upon the removal of North Gangway Rock.
2. The removal of the wreck of the schooner *Globe* completed.
3. 475 cubic yards of material removed from the channel in the "Lower Falls," above Haverhill.

Under the appropriation made by Act of March 3, 1871 (which by the Act had to be applied exclusively to the improvements *above*

Haverhill), proposals were invited for continuing the dredging at the Lower and Upper Falls to a width of sixty feet and a depth of four feet at mean low water; and on the 31st of May, 1871, I made a contract with Mr. W. S. Fretch of Boston, Mass. (the lowest of three bidders) for doing the work at \$10 per cubic yard, to the extent of the funds available therefor.

Under the contract, Mr. Fretch has excavated and removed 2,100 cubic yards from the "Lower Falls," in completion of his contract. In addition to this a ledge which extends directly across the channel at these falls, has been partially broken up, ready for removal.

The work thus far done consists in excavating to a width of 60 feet a channel through the lower portion of the falls up to where crossed by the sunken ledge; the partial breaking up of the ledge; and some dredging in the channel above the ledge. So that, with the work done at the "Lower Falls" in the years 1870 and 1871, the channel may be considered as about one-half completed; but not so as to give a continuous channel of the required depth through the falls.

The amount that has thus been expended upon this work during the six months ending Dec. 31, 1871, is \$24,399.94, leaving an unexpended available balance of \$603.72.

Finding, during the progress of the work, that additional surveys would be necessary for its proper prosecution, I have had, with your approval, an examination made of the river, from the foot of Hazeltine Rapids, up as far as Lawrence (a distance of $7\frac{1}{4}$ miles), and accurate surveys made at the several rapids and shoals requiring improvement.

This survey shows that the amount of work required for improving the navigation of this river greatly exceeds that heretofore estimated for, and that, although it is practicable to make the river navigable with a depth of four feet of water at low water through the "Hazeltine Rapids" and the "Lower Falls," to the head of tide-water, it will be impracticable to make it navigable through and above the "Upper Falls" (without a vast amount of excavation) except in the most favorable condition of the river, which will be stated in a special report as soon as the drawings shall be completed.

The following is an estimate of the quantity of work to be done, and the cost of same, for thus improving the navigation of this river, viz. :—

1. Excavating a channel (60 feet wide and 4 feet deep, at mean low water through "Hazeltine Rapids,"—1,900 cubic yards, at \$6,	\$11,400 00
2. Completing the channel (to same width and depth) at the "Lower Falls,"—2,500 cubic yards, at \$6,	15,000 00
3. Excavating a channel (60 feet wide and 4 feet in depth) at the "Upper Falls," and removing rocks from channel below—6,500 cubic yards, at \$6,	39,000 00
4. Excavating channel through shoals Nos. 4 and 6 (above "Upper Falls")—4,000 cubic yards, at \$3,	12,000 00
5. Engineering expenses and other contingencies, say,	7,600 00

Estimated cost of obtaining a navigable depth of four feet, up to the Lower Lock, at Lawrence, at an ordinary stage of the river—being in addition to the amount already expended thereon—is,	\$85,000 00
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Even with this work, it is believed that the velocity of the current (which, in a medium stage of the river, is three miles per hour) would make navigation exceedingly difficult; whilst a channel, excavated to a width sufficient to materially reduce this velocity, would so lower the river above as to require the removal of several bars not herein estimated for.

The only practicable method of making this river navigable, at all stages of the water (except in freshets) up to Lawrence, is, in my opinion (which has been confirmed by the results of the recent survey), to build a dam and lock at the "Lower Falls," about 1,000 feet in length, and nine feet in height, the cost of which, with the dredging that would be required at "Hazeltine Rapids," the "Lower Falls," the "Upper Falls" and above, would probably be not less than \$130,000, in addition to the work already done.

This would not only give a channel that would be navigable in all stages of the river (except in freshets) by boats drawing four feet of water, but would obviate all the rapid and dangerous currents at the "Lower Falls" and above.

III. TAUNTON RIVER, MASSACHUSETTS.

The improvement contemplated for this river consists in the excavation of a channel to a width of sixty feet, and a depth of

four and one-half feet at mean low water (or nine feet at mean high water), through the several shoals which obstruct its navigation between Dighton and Weir village, in the city of Taunton—a distance of six miles.

By Act of Congress of July 11, 1870, there was appropriated for this work the sum of . . .	\$10,000 00
And by Act of March 3, 1871,	10,000 00
<hr/>	
Total,	\$20,000 00
Amount expended during the fiscal year ending June 30, 1871,	608 00
<hr/>	
Balance available July 1, 1871,	\$19,392 00

After inviting proposals for this work, a contract was made, March 29, 1871, by my predecessor (Gen. Foster) with Mr. Emery R. Seward, of Albany, N. Y., for excavating the proposed channel through "The Needles," at five dollars per cubic yard.

This contract was commenced on the 7th of July, and was satisfactorily completed on the 22d of November, 1871; whereby the channel at this place, which before was the most dangerous and difficult of any in the river, is now safe and unobstructed.

IV. PLYMOUTH HARBOR, MASSACHUSETTS.

The improvement contemplated for this harbor consists in the construction and repairs of a bulkhead and jetties on Long Beach, made for the preservation of the beach, and for its protection from the storms to which it is exposed.

This beach serves as a breakwater, and affords to the harbor its only protection from the easterly storms.

By an Act of Congress, approved July 11, 1870, there was appropriated for the improvement of this harbor,	\$10,000 00
And by Act of March 3, 1871,	10,000 00
<hr/>	
Total,	\$20,000 00
Amount expended during the fiscal year ending June 30, 1871,	11,093 49
<hr/>	
Amount available July 1, 1871,	\$8,906 51

On the 26th of May, 1871, I made a contract with Mr. J. A. Blaisdell, of Greenland, N. H. (the lowest of five bidders) for completing the brush bulkhead and jetties near the extremity of Long Beach, at \$3.86 per linear foot; and on the 27th of May I made a contract with Mr. George Clapp, of Boston, Mass. (the lowest of six bidders), for delivering and piling stone upon the beach, at its outer extremity, so as to connect the beacon with the wooden bulkhead, at \$2.25 per ton.

Work was commenced under both these contracts in the month of June; that on the brush bulkhead and jetties was satisfactorily finished in August, 1871, under which 641½ linear feet were completed; and the contract with Mr. Clapp for the stone bulkhead was completed in the month of September, 1871, under which 2,028 tons were delivered and placed in position.

In addition to the work completed under the contracts, extensive repairs have been made upon the brush bulkhead and jetties along the beach, and beach grass planted in places where most necessary.

These repairs were also finished in the month of September, 1871, when all the contemplated works were completed, with the expectation that nothing further would be required, unless rendered necessary by storms, from which the beach is at any time liable to injury.

The strength and efficacy of these bulkheads and jetties were put to a very severe test by the extraordinary gale of November 15, 1871, during which the tide rose about five and one-half feet above its ordinary height; and by which some damage was done to a portion of the bulkhead built in 1870, but not so serious as to endanger the security of the harbor. These damages it is contemplated to repair early next spring.

The unexpended balance of appropriation which is now available for this work, is \$868.38.

V. HYANNIS HARBOR, MASSACHUSETTS.

The improvements contemplated for this harbor consist in the reconstruction of the breakwater, in the following manner, viz.: The random stone of the old work is rebuilt from low water, where it has a thickness of twenty feet, up to about four feet above high water, where it is from sixteen to eighteen feet thick; upon this foundation is placed a top wall (in two courses), having a rise of three feet, and a width of ten feet, strengthened by dowels of composition metal.

This breakwater is about 1,170 feet in length, of which 695 feet had been rebuilt on the first of January, 1870.

Under the Act of Congress of March 3, 1871, by which the additional sum of \$10,000 was appropriated for this work, I made a contract on the 9th of June, with Mr. George Clapp, of Boston, Mass. (the lowest of two bidders) for completing 250 running feet of the breakwater, at \$37.50 per running foot.

Soon afterwards he commenced work, having on the 30th of June built up 175 running feet, ready for its top wall. In the month of September he had rebuilt and finished 250 running feet of the work in completion of his contract.

The unexpended balance available for the work on

the first of July, 1871, was	\$8,906 49
Amount since expended thereon,	8,726 34

Balance (on hand) available January 1, 1872,	\$180 15
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There now remain to be rebuilt 225 running feet, the estimated cost of which, including contingencies, is \$10,000.

VI. PROVINCETOWN HARBOR, MASSACHUSETTS.

The work done up to the first of July, 1871, for the improvement and preservation of this harbor, was as follows, viz. :—

1. Bulkheads and jetties of various descriptions had been built from time to time, along Beach Point, for its preservation and protection, both by the United States Government and by the local authorities.

2. A dike was built in 1868, by the State of Massachusetts, across the outlet of East Harbor Creek.

3. A dike was built in 1869, by the United States Government, across East Harbor Creek, at the "Wading Place," near "High Head," about two miles above the outlet of the creek.

4. A dike was built in 1870, across the head of Lancey's Harbor, at Abel Hill, in order to prevent the washing and flowing of sand through that place down into the main harbor of Provincetown.

5. Wooden bulkheads and jetties had been built at different times for the protection and preservation of the beach on Long Point.

6. A stone apron-work had been commenced for the protection and preservation of the outer end of Long Point, opposite the light-house and the "Three-gun battery."

7. Beach grass had been planted on Long Point, Cove Section and Oblique Section; and at the last two places brush had also been laid for their further protection.

The work contemplated to be done for the further improvement of the harbor, is as follows, viz:—

1. A dike across the head of Lancey's Harbor, at Abel Hill.
2. The repair of the existing bulkhead and jetties, and planting of beach grass along Beach Point and the State dike.
3. Completing the stone apron-work for the protection of Long Point, requiring about 1,000 tons.
4. A work to prevent the extension of the flats between Stevens' Point and Lobster Point.
5. The planting of beach grass for the protection of the outer sand hills lying between the State dike and Cove Section, for an extent of nearly one mile.
6. To provide for annual repairs of the bulkhead and jetties.

The estimated cost of the above works is,	\$19,029 25
The balance of the appropriation available for this harbor, on July 1, 1871, was,	\$9,029 25

On the 25th of August, I submitted a project for the further improvement of the harbor, with the funds available therefor, based upon the information furnished by the very accurate and comprehensive survey recently made by Mr. Sophus Haagenon, assistant civil engineer.

This project, which was approved by the department, embraced the three following items, viz.:—

1. Building by contract a dike, on a plan submitted, across the head of Lancey's Harbor (at Abel Hill) in order to prevent the flow of tide and sand into the inner harbor of Provincetown.
2. Repairs of the brush bulkhead and jetties, and planting of beach grass along Beach Point and the State dike.
3. Extending the stone apron-work for the protection of Long Point.

Proposals were invited for building the dike, and, on the 17th of October, 1871, a contract was made with Mr. Samuel Dyer, of Truro, Mass. (the lowest of five bidders), for doing the work for the sum of \$5,250, under which contract the dike is to be finished on or before the 30th of June, 1872. Notwithstanding the unfavorable weather, Mr. Dyer has made satisfactory progress in his work, with the probability of completing it in March next—all the round piles being now driven, capped and braced, and a commencement made on the sheet-piling.

Extensive repairs have also been made upon the bulkhead and jetties on Beach Point, and beach grass planted, and three hundred

and eight tons of granite deposited near the extremity of Long Point, in conformity with the approved project.

The unusual gale of the 15th of November, 1871, during which the tide rose about five and one-half feet higher than usual, did much damage to the bulkhead and jetties on Beach Point near the State dike (since partially repaired), whilst, at the southern part of the beach, its condition was very much improved by the gale. The beach at the outer end of Long Point was unchanged by this gale, although the wooden bulkhead around the light-house was washed away.

The available balance of the appropriation pertaining to this harbor, on the 1st of January, 1872, is,	\$6,651 30
Of which there will be due for dike, when completed,	5,250 00
Leaving a balance of	\$1,401 30

to be applied to additional repairs of the bulkheads and jetties on Beach Point.

Very respectfully, your obedient servant,

GEO. THOM,

Lieut. Col. of Engineers, B't. Brig. Gen., U. S. A.

MEMORIAL TO CONGRESS IN BEHALF OF EDGARTOWN HARBOR.

To the Honorable Senate and House of Representatives of the United States, in Congress assembled:

The undersigned, Harbor Commissioners of the Commonwealth of Massachusetts, acting under the authority and on behalf of the said Commonwealth, respectfully present the following memorial:—

About two years ago, during a violent gale, the southern inlet to the harbor of Edgartown was wholly blocked up by masses of sand driven in by the waves of the sea. This event not only deprived the local community of a direct communication with valuable fishing grounds, and lost to stranger vessels, approaching from sea, a means of obtaining pilots before venturing across the shoals or through the dangers of Muskeget Channel, but it so changed the regimen of the currents in the harbor itself that the main channel, directly in front of the town, began to grow narrower and more shallow.

Apprised of these changes, by the people of Edgartown, this Board made immediate application to the Superintendent of the Coast Survey for information, in response to which, all the details of past examinations were furnished and a new survey ordered. The execution of this new work was assigned to officers of long experience in studies of this kind, who were, happily, very familiar with this particular neighborhood—the scene of their early professional experience. The field-work was commenced at once by these gentlemen, under the personal inspection of their chief, who has recently transmitted to this Board their reports in full.

These reports show that the complaints and fears of the community were by no means groundless; that the south beach has become a continuous and firm barrier which may resist for many years the attacks of the sea; and that the order of the harbor streams has been so completely changed that the scour, upon which the maintenance of the main channel depended, has greatly diminished. Moreover, they furnish the measure of the ill effects already developed near the main entrance, where the area of channel section, in front of the town, has declined twenty-five per centum.

As a port of refuge this harbor, from its peculiar situation, has been of inestimable value to maritime commerce.

The south-eastern coast of Massachusetts is the most dangerous portion of the Atlantic shore. Its widely extended shoals, and its bewildering currents, have been the dread of the mariner since the earliest settlement of our country. Lying so near the track of much of the foreign commerce of the country, as well as in the route of a vast coastwise trade, its dangers must be braved every day of the year by a fleet of merchant vessels larger, it is said, than any other in the world. In the midst of this region of danger, and as if to redeem and mitigate its perils, lies the harbor of Edgartown, offering good anchorage, always easy of access, and perfectly sheltered. Situated at the junction of Muskeget Channel with Nantucket Sound, and but a short distance from the head of the Vineyard Sound, it may be said to be always *under the lee* for vessels approaching our shores from any direction. It has, furthermore, gained additional importance of late years, because the bight of Monomoy, known to seamen as the "*Powder Hole*," which formerly served as a refuge in easterly gales, has been wholly destroyed as an anchorage by an encroachment of sands, not unlike that which now threatens the harbor for which we plead.

The frequency of the surveys made by the government during the last twenty-five years, at and near Edgartown, indicates the importance which has long attached to the exploration of all the

resources of this national harbor; and the dependence of its main channel upon the tidal circulation which its two openings permitted, was announced by the Coast Survey, as a curious physical fact, more than fifteen years ago, before any apprehension of injurious change existed, and before any project of improvement had been suggested.

During the last quarter of 1870 and the first quarter of 1871, two thousand vessels entered the inner basin of Edgartown, and most of these sought only shelter; for this port has little trade of its own, and is not, like Vineyard Haven, a halting place to wait for wind and tide, in ordinary weather.

The last two winters have not been very severe, yet the difficulty from ice in the harbor has been unusually great, and is supposed to have resulted from the feeble movement of the currents, and from the absence of the warmer ocean water since the inlet closed.

That nothing might be wanting in our deliberations upon this subject, we have submitted all the evidence to our Advisory Council, composed of United States officers of long experience, and it is their summing up of the case that we give below:—

“The recent sanding up of the opening through Cotamy Beach, deprives the harbor of Edgartown of that tidal circulation upon which has depended, we confidently assert, the maintenance of the fine channel leading from the outer roadstead to the perfectly sheltered basin near the town. Should the beach remain closed, we have no doubt that this channel will be injured, and a valuable national harbor of refuge deprived of one of its greatest advantages. Except Wood’s Hole, which is at times difficult of access, this the only perfectly safe port between Provincetown and Newport. The regimen of the currents has wholly altered since the inlet was closed, and an accumulation of sand actually commenced opposite the town.

“An acquaintance with the hydrography of this neighborhood, at times very intimate, during a quarter of a century, discovers to us no fundamental changes in the physical conditions, and we believe that with the artificial opening of the inlet, nature will at once respond to the efforts of the engineer, resume her good offices, restore the former regimen of the currents, and maintain perhaps for years, all the advantages that have distinguished this harbor. That the new inlet will repeat the history of those which have before existed, shifting eastward and ultimately closing, we do not doubt; but the remedy may always be easily repeated and will never be expensive.”

In view of these well-determined facts, and the conclusions care-

fully based upon them, your petitioners pray that an appropriation may be made during the present session of Congress, for re-opening the southern passage-way from the harbor of Edgartown to the ocean.

JOSIAH QUINCY.
DARWIN E. WARE.
J. N. MARSHALL.
F. W. LINCOLN.
W. T. GRAMMER.

REPORT OF PROFESSOR HENRY L. WHITING ON EDGARTOWN HARBOR.

BOSTON, MASS., January 2, 1872.

PROFESSOR BENJAMIN PEIRCE, *Supt. U. S. Coast Survey.*

DEAR SIR:—In compliance with your instructions of 18th July last, I proceeded to Edgartown, Martha's Vineyard, to make a survey of the changes in the topography of the harbor for the purpose of comparing the results with those of my former surveys of this locality, and in connection with the physical surveys of Prof. Mitchell, to ascertain, if possible, the effect of these changes upon the harbor.

The comparison of the surveys just made with those of previous dates—1846, 1854, 1855 and 1856—giving intervals of fifteen and twenty-five years, affords data for most interesting study, and gives an accurate exhibit of the action of waves and currents along this section of the coast.

In his former and late reports, Prof. Mitchell has stated the peculiar physical relation of the tides of the Vineyard and Nantucket Sounds to those coming upon the south shores of the islands of Martha's Vineyard and Nantucket, and the circulation of currents through Edgartown Harbor, and the former opening in Cotamy Beach. I will not, therefore, discuss these subjects in my report, but merely give their effects as they appear.

At the time of my first survey in 1846, the opening through Cotamy Beach was at the eastern corner, so to speak, of the bay, but not beyond the south-western point of Chappaquiddick Island; in fact, the inlet was formed by this point of Chappaquiddick and the east end of the beach, and was about two thousand feet in width. Within the opening, however, were two small sand islands, with channel-ways between and on either side of them. This con-

dition of the inlet corresponded in its general location and width to that shown on the maps of Des Barres of 1776.

In 1856 I was ordered by Prof. Bache to make a resurvey and examination of this same locality, in order to determine the position and dimensions of the new opening which was reported to have been made by a then recent storm.

By this survey I found great changes had taken place since 1846. The old inlet had worked about one mile to the eastward of its former site, and the point of the beach had lapped by the end of Chappaquiddick over half a mile. The shore of this island, along its south-western face, had washed away to the extent of about 2,300 superficial feet. This action had changed the character and capacity of the inlet from a broad opening, of 2,000 feet, directly opposite the waters of the bay, to a much narrower channel confined between the fast land of Chappaquiddick and the beach. This waterway between the ocean and the bay was about 3,000 feet in length, and about 500 feet in width.

The new inlet had broken open about opposite the middle of the bay, and was, at the time of my survey,—1856,—about 1,400 feet in width, thus restoring the total inlet capacity, so far as width was concerned, to nearly that of the old inlet of 1846.

Since 1856 we have had no determination of the beach until the surveys made last summer, when it was found to extend across the entire south part of the bay, with no opening into the ocean. We have, however, quite reliable local information concerning the intermediate changes, from which we have obtained the following general facts:—

Soon after the “west opening,” so called, of 1856, was formed, the “east opening” closed, and the new west opening, following the law of motion which seems to govern all the inlets on the south side of the island, began its movement eastward, and continued until it reached the site of the former inlet of Des Barres, and of the Coast Survey of 1846, passed on to the site of the inlet of 1856, and still continued working eastward until the point of beach forming its outer chop reached a point in line with the general trend of the east shore of Chappaquiddick. Here the rapid tidal currents of Muskeget Channel checked its further progress. For a time the tidal currents into and out from Cotamy Bay battled with the sea-dash upon the shore, the latter gradually gaining ground upon the current power, crowding the beach further and further toward the main land of Chappaquiddick and narrowing the waterway between them, until, at the occurrence of a storm and

tide favoring the action, the most easterly portion of the beach was beaten in upon the island by the ocean waves and the inlet closed. This happened in 1869, since which time the beach has remained intact, and all the tidal action and influence of a southern inlet, connecting the waters of the ocean and the sound through the channels of Edgartown Harbor and Cotamy Bay, has ceased.

There is the tradition of a continuous beach, and the closing of all inlets, as at present, in the early part of this century; and that people passed with teams from the main island to Chappaquiddick, but that the link was only temporary, a new opening breaking through the beach again in a few months after it was closed. With this exception, there is no record or tradition of the non-existence of an inlet through Cotamy Beach since this section of the coast has been known.

It is an interesting and important fact that we are able so accurately to determine the extent and nature of the changes which have occurred in this locality within the last twenty-five years, particularly in this beach, which is a type of many others along the sandy portions of our sea-coast, and presents much the same barrier against the encroachment of the sea, preventing the wasting action of storm-waves from extending into bays, lagoons and ponds.

The length of Cotamy Beach, from east to west, is about three and a half miles, and its average width about 450 feet. As shown by my first and last surveys, this beach has been beaten bodily northward a distance about equal to its width. As this beach has re-formed its general natural slopes while changing its position, we find a present depth of about 8 feet below high water over the area occupied by the beach itself in 1846, and also a corresponding depth on the inside of the beach; so that in determining the amount of sands which have been moved we must take them from above the plane of about 6 feet below high water; the average height of the beach above high water is about 8 feet. This gives a gross amount of about 116,500,000 cubic feet. In other words, a bank or mole of sand, 18,500 feet in length, 450 feet wide and 14 feet high, containing 116,500,000 cubic feet, has been beaten in upon the bay and shore, by the steadily encroaching action of the ocean waves, in a period of twenty-five years, a distance of 450 feet. This is not a case of any great convulsion, or powerful current action. It is but a fair illustration of the gradual but unceasing *waste* which is going on upon such shores.

The island of Martha's Vineyard was probably visited and even settled upon by the early colonists. How great must be the contrast of the present shores with those they then explored, when we

consider that, according to the ratio of change, Cotamy Beach must then have been 4,500 feet to the seaward of its present line!

In extending my survey westward from Cotamy along the main shore of the island, I found the same encroachment of the ocean going on. Two ponds of some acres in extent, and having local names, were, at the time of my survey in 1846, about 450 feet back from the shore line. These ponds are now entirely obliterated. The site of one is now occupied by the sand-hills of the beach, while a small tract of marshy ground marks the inner borders of the other. I found no important changes in the inner shores of Cotamy Bay, or at points not under the immediate influence of the ocean forces.

With regard to the question of opening Cotamy Beach by artificial means, and thus restoring the former regimen of the bay and harbor, there seems to be but one answer to be given,—it should be done at once.

The great value of Edgartown Harbor as one of shelter, and the *only perfect shelter*, within reach of the mass of vessels sometimes caught by bad weather in the dangerous approaches to Cape Cod; the importance of an inlet or passage-way from the harbor southward for the smaller pilot-boats peculiar to the island, which in certain winds and storms can safely and quickly reach vessels needing a pilot off Muskeget Channel, *through this southern inlet*, when it would be *impossible* for them to round Cape Poge, or reach the ground of danger by any other route; the fishing interests of Edgartown and its vicinity—an interest of much value, shared by a large proportion of the population, and so seriously affected by the loss of this safe and direct pathway to their fishing grounds—all call for action and relief in the matter of this closed inlet.

The most favorable point at which to reopen Cotamy Beach seems to be at or near the west end or head of the bay.

The arguments in favor of this location are as follows:—

1st. The greater length of time that the inlet will probably remain open, assuming that it will move from west to east as fast, and close as soon after reaching its eastern limit, as the former inlets have done.

2d. The fact that this contracted section of the bay, by confining the tidal currents between the main land of the island and the beach, as they flow to and from the actual inlet, favors the formation and maintenance of a channel, through the shoal-ground bordering the beach, into the deeper waters of the bay.

3d. Economy in cutting through the beach, as the cross-section at this point is about the minimum.

Although an opening through the beach sufficient to merely start

the water running, if made at the time predicted by Prof. Mitchell, may, and probably will, create a natural inlet, and such an inlet may answer the physical demands required to restore the tidal circulation through the harbor, still, the uncertainty of a single tide doing the required work, and the contingency of an intervening storm or ocean swell preventing the continued action of the succeeding tide, render the scheme of depending upon the scouring power of the tide alone a questionable one, unless accompanied by a prepared pathway for it as far through the beach as practicable, and of such a width as shall at once secure, when opened, a stream of considerable volume.

Apart from the physical importance and effect of opening an inlet through the outer beach, there are difficulties of navigation which such an inlet, only, would not relieve.

As seen on the map or sketch which Prof. Mitchell and myself jointly append to our reports, there is a range of shoal ground bordering the beach, and extending from east to west along the entire south front of the bay. Prof. Mitchell has stated in his report that this shoal ground has increased, within the last fifteen years, by the amount of about one million of cubic yards. This coincides with the popular opinion of the constant accumulation of material upon this ground, which is now so extensive and so shoal that it is difficult for the peculiar class of boats required for the outside fishing and pilotage to cross it; in fact, they cannot do so, except by one or two tortuous and imperfect channels.

If a channel-way through this shoal ground were made in connection with a new inlet through the beach, it would, of course, give great relief to the boating interest, both for pilotage and fishing. Here again the western section of the bay, before alluded to, presents naturally favorable ground for such a channel, by improving what was once, probably, a natural channel leading to some former inlet.

The question of how much this pilotage and fishing interest is worth, or what the value of the former may be to the general security of navigation, I will not presume to answer. It is not, however, an unreasonable supposition, that, within one year from opening an inlet and making such a channel-way, a vessel in distress outside may be saved by a pilot reaching her through this channel, and that the value of the vessel and her cargo may be worth as much or more than the amount it will cost to make the channel-way. This is apart from the question of the saving or loss of life.

In connection with this view of the harbor question, and in conclusion of the general subject, I have made some estimates concern-

ing such a channel and inlet as I have named, which I submit for your consideration as suggestive items.

As a basis for the general dimensions and character of a channel and inlet as proposed, I have taken a width about equal to the narrowest section of the natural passage-way between the harbor and bay, which is about 300 feet. This is not wider than desirable for a beating channel. The depth is regulated by the class of boats in general use, which require about four feet at mean low water.

As before stated, there are, in this part of the bay, the traces of a former channel through this shoal. By following the general course of this old channel, and removing such portions of the shoal as in places now block it up, a passage-way 300 feet wide and four feet deep may be obtained by the excavation of about 41,000 cubic yards of the material of the shoal.

A corresponding excavation through the beach to the level of mean high water only, which is probably all that will be needed to insure a successful inlet, will require the removal of about 14,000 cubic yards of sand. * * * * * * *

Upon the map, before referred to, which accompanies Prof. Mitchell's and my reports, I have shown the outlines of the beach and inlets as they have been determined by the several surveys which I have made. These surveys have all been based upon the original triangulation, and referred to the same base lines, so that the changes shown are *absolute*. The last survey, although not involving much detail, required considerable time and labor in its execution. The very changes which it was its purpose to determine had caused the loss of all points and land-marks along the outer shore of the island, so that a new series of points, based upon the light-house and spires of Edgartown and the station on Sampson's Hill, had to be extended to the south shore of the island and to Chappaquiddick before the survey could be made. I had but a small party organization, and am indebted to Prof. Mitchell and Mr. Marinden for many favors and much assistance in the execution of my field work.

Very respectfully submitted,

HENRY L. WHITING.

REPORT OF PROFESSOR HENRY MITCHELL ON
EDGARTOWN AND NANTUCKET HARBORS.

DEAR SIR:—I very respectfully submit the following report of my work in Section I., executed during the past season:—

In response to a call from the Massachusetts Board of Harbor Commissioners, you directed me to extend my project for the season, so as to cover, as closely as required, the harbors of Edgartown, Vineyard Haven and Nantucket, with their approaches by sound and sea. Presuming that the Board I have referred to will be supplied with such portions of this report as may be deemed useful in considering the petitions for improvements which have come in from said localities, I shall arrange my notes in three brief sections without reference to the actual order in which we have pursued the inquiries. I shall first give a limited *resumé* of the physical aspect and peculiarities of the neighborhood; then from a strictly practical point of view recount the results we have reached, and make such suggestions as these results seem to warrant; and finally furnish in the usual form the elements of the field work.

§ 1. *Physical Aspect and Peculiarities.*—A glance at the map of New England reveals, in the general direction of the valleys, ponds, harbors, bays and sounds, the traces of great forces moving from the north and east—forces which controlled, or developed themselves, in the movements of the glaciers, and ceased to operate, perhaps, before the present agencies of change existed. If we descend from the general features to the study of details, we discover that the drift of the glacial period has been washed down from the hills by the rain, torn from the headlands by the waves, and strewn along by the sea, so that the original depressions are being filled up and new features appearing, which we easily recognize as the result of natural operations now in progress.

Upon the islands of Martha's Vineyard and Nantucket, where the depressions are generally transverse to the trend of the coast, barriers of sand have been thrown across them at the sea margins, both upon the north shore and upon the south, but more conspicuously on the latter which is more exposed to the storm waves of the ocean. One may recognize the strip of beach that crosses the lagoon of Vineyard Haven as the same kind of "*littoral cordon*" as the ridges of sand that cut off Tisbury and other ponds from the ocean. Chippaquiddick Neck at the entrance to Edgartown differs

from Cotamy Beach only in its exposure. The main entrance to Edgartown from the north can only have been maintained by the tidal circulation, and the southern opening closed simply because this circulation was unequal to the task of resisting the constructive efforts of the waves. That there was once an open passage-way from the sound to the ocean through this harbor can scarcely be doubted, for the bluffs on either hand bear witness to the wear of seas to which, under the present circumstances, they can never be subjected. It is probable that Cotamy Bay, immediately after the melting of the glaciers, was an open fiörd; that the sand driving along shore from the westward converted the fiörd into a bight, and the bight into a lagoon.

The history of Greytown Harbor, Nicaragua, which I had the opportunity to study while a member of the Committee of the National Academy appointed to investigate it, furnished a similar order of changes shown by comparative surveys. In this instance a cove became successively a bight, and a lagoon, by the advance of a sand drift across its mouth. When the sands had nearly crossed, the opening took the form of an inlet with a depression at the pass, and a bar outside. This inlet struggled for existence but finally closed. The ponds on the south sides of Marthas Vineyard and Nantucket, have all perhaps been little fiörds which have been shut up by the coast sands.

The difference, however, between Cotamy Bay and the other sand barred fiörd, is very great when we consider that with two openings a great tidal circulation is possible. I cannot altogether agree with Prof. Whiting in supposing that the beach has gone on accumulating till it presents a barrier difficult to overcome, because the power of the tidal circulation seems to me out of all proportion to the obstacle. I incline rather to the impression that the outlet shifting to the eastward, has in this instance happened to run its course and close on the border of Muskeget Channel, before any great storm had occurred to open a new pass to the westward. It will be seen, from what I shall say hereafter, that the opening must gradually lose its strong tidal current as it moves eastward, and very decidedly when it reaches Muskeget Channel, where the contrasts of tidal elevations, within and without, diminish.

Prof. Whiting's repeated topographical surveys along the south side of Martha's Vineyard show that the bluffs are being continually undermined by the sea, and since the waves, running before the prevailing westerly winds, strike the shore diagonally, there is a tendency of all materials to work down to the eastward,—a tendency which seems to have resulted in the choking up of all the indenta-

tions of the original shore line, and finally in the formation of shoals on the border of Muskeget Channel, where the coastwise movement is turned off by the great stream from the sound. I have no doubt that Wasque Shoal has received supplies from the entire length of the south shore of the island, although in the main, perhaps, it is a product of the wear of the east shore of Chappaquiddick.

This shoal, like the the False Hook at the entrance to New York, lies in the debatable district between opposing movements of the sea. In many respects, the openings through Cotamy Beach, in location and history, have resembled those through Sandy Hook, at Naversink Highlands, known as the "Shrewsbury Inlets." In both places the shifting has been induced by a diagonal set of the waves, and in both places the openings after long travel have been prone to close in particular neighborhoods, where they have been compelled to halt and make a struggle for existence.

The material which falls from the headlands into the sea, is not borne far off, but continually crowded towards the shore. As the waves drive up the beach great masses of sand and stones are forced on shore, but the reacting "undertow" carries back always a portion of the finer material. By the grinding action of the breaker, and the *selecting* operation of the undertow, the beach becomes largely composed of fine sands easily caught up by the dry winds and formed into dunes or "*galls*" as they are properly called upon Nantucket. The sea in its onset is constructive up to a certain elevation; it seems disposed everywhere to preserve a dike, but this barrier, unless augmented by wind-borne material, never exceeds a certain limit. It does not restrain the overleaping sea, in the fury of the storm, but limits its peaceful domain.

The most casual observer may distinguish in Cotamy Beach a contrast of appearance between the *wind-worn* and *water-worn* districts,—the former characterized by irregular mounds, the latter by smooth surfaces declining in either direction from a crest line to the sea; in the one case, the contours are apparently groups of concentric curves, in the other, parallel straight lines. In the profiles of different cross-sections, the two forms of beach are still more distinctly shown. So that in most cases we can positively assert that *this* is a *dune* section, where the wind arranges, and *that*, a *natural dike* still washed by the storm seas.

There are, it is true, some sections where the wind and the sea have both left traces of their struggle for supremacy; but these present little confusion to the careful observer, who easily distinguishes the traces of the water from those of the wind.

The wind plays its part upon a stage previously raised by the

water, and builds higher still. The coarse grasses which take root in the dunes arrest the flying sands still more effectually, and with them the fertilizing dust of the shore. In this way, the levee thrown up by the sea is gradually strengthened, till it becomes a permanent barrier against the storm seas.

Where exposed to the open ocean, the levee maintained by the sea is seven to eight feet above ordinary high water; in bays and sounds, where somewhat sheltered, it is less. The first three sections upon our map are those of sea-built dikes. Of course storm seas easily pour over the natural levee and these, by sweeping the sands from the front to the rear, cause the levee to move back without changing its form, usually. Its movements are like that of a dune, but its slopes are the reverse.

The island of Nantucket is, mainly, a heap of glacial drift. Except a very remarkable bank of oyster shells which crops out from Sankaty Head, about sixty feet below the brow of the cliff, no ante-glacial deposit is found. Mr. Edward C. Cabot, when attached to the party of Lieut. Charles H. Davis, first called attention to this exceptional feature upon the eastern shore, and ascertained that it extended back from the sea a long way and was struck in digging wells in the interior of the island. It would be very interesting to explore this deposit, as you have encouraged me to do, and to ascertain if it is a shell levee like those I have seen upon the Bahama Islands. If it is, its *strike* and its fore and rear slopes would reveal the whereabouts of the ocean, and perhaps the height of waves in the ante-glacial age. Great Point, Coatue and the larger part of Smith's Point are modern formations and composed, probably, of material torn by the waves from the seaward side of the island. In the midst of the town is a long bluff, where the drift deposit has been undermined by the sea, probably before the shelter offered by Great Point and Coatue existed. I refer here to the *Bank* between Orange and Union Streets, and its continuation in the quarter known as "North Shore." These ancient headlands are now covered with houses, and their slopes grown over with grass.

The Haulover, which it is proposed to cut through, connects the drift mound, known as Coskata, with the main body of the island, and separates the Upper Harbor from the ocean. It has always been a portage for fishing boats, as its name implies, and has nearly the same form and area upon the maps of Des Barres, 1776, William Mitchell, 1838, Coast Survey, 1846, and Dr. Ferdinand C. Ewer, 1869. The section given upon our sketch is the mean of three lines of levels following depressions, from the harbor on the one side, to the ocean on the other. The distance from rear to

front is unusually short, yet still I claim that the form is that of a sea-built dike. But even if this barrier be, as Mr. Joseph B. Macy and others at Nantucket, assume from their examinations, a remaining strip of the original *drift*, we might still expect its exposed portion to wear the form impressed upon it by the sea; so that I do not give much weight to my own view, which is *literally* superficial as yet.

In the natural formation of an opening through the *littoral cordon* of the coast, the waves play only a preliminary part; *it is the current which digs the channel*. The overleaping waves weaken the dike, but it is by filling the basin behind to overflowing that the breach is made wide and deep. In cases like Chatham, where the length of exposed beach is in very great ratio to the area of the basin, the latter is very liable to overflow, and inlets are the frequent products of great storms. The Haulover beach, on the contrary, is so short from Coskata to Squam that it does not admit many overleaping seas, and therefore the basin within never perhaps swells to overflowing.* The experiment proposed is, therefore, one which nature may never have tried.

The distinguishing peculiarity of the district under examination is its unparalleled tidal currents. Nantucket was called by the Northmen "Straumey" (Stream Island), and the sound Straumfiörd.† There is no other part of the world, perhaps, where tides of such very small rise and fall are accompanied by such strong currents running far out to sea. The navigator, approaching the coast, scarcely makes a land-fall before he finds his ship "moved onward from beneath," and the same wonder fills him now, that first perhaps so long ago "mingled strangely with the fears" of those ancient mariners.

There approach our coast from the ocean two oscillations of the tide, which meet, or (as you express it) "*form their node*" southward of Nantucket Island. From Great Point, Nantucket, all

* I follow the spelling of the Indian names given upon the interesting map of the Rev. F. C. Ewer, D. D., published in 1869.

† I infer that the island discovered 1005 by Thorfinn the Hopeful, "*past which ran strong currents, which was also the case further up the fiörd*," must have been Nantucket. Most of the commentators upon the *Sagas* award the discovery of the south shore of New England to Leif the son of Eric, but his mention of "*much land left bare by the tide*," is fatal to this interpretation of his account. Vinland must have lain northward of Cape Cod as seen by Leif. The palm of first entry upon our field of inquiry, belongs to Hopeful Thorfinn.

Curiosity has led me to consult Wheaton's Northmen, the *Antiquitates Americanæ*, and some MS. kindly sent to me by F. S. Stallknecht, member of the Royal Society of Antiquaries at Copenhagen. It was not until this Report went to press that DeCosta's new book on the "Pre-Columbian Discovery of America" came to my notice.

along the outer coast of America to the northward, high water occurs at, or shortly before, the transit of the moon; while from Smith's Point, Nantucket, along the outer coast to the southward, high water occurs four or five hours earlier. "*South moon makes high water*" and "*South-east moon makes high water*," are the sailor's rules respectively applied to the two divisions of the coast we have named. My very close observations, made in 1854, show that the nodal line intersects the shore line of Nantucket between the meridians of $70^{\circ} 0'$ and $70^{\circ} 05'$, i. e., a short distance to the westward of the shoals. These two oscillations entering the sound, the one by Gay Head and by Muskeget Channel, and the other by the Eastern Entrance, give very complicated tides between Tarpaulin Cove and Tuckernuck. In the small tides of Holmes' Hole, Muskeget Channel and Weweeder (south side of Nantucket), there are sometimes four high tides in one day, distinctively given by gauging. But I must not enter upon details that would but complicate the conception; and I would remark by the way of preparing the reader to trust my calculations, given below, that the phenomena present really no complications, when simultaneously observed from point to point.

§ 2. *Edgartown Harbor*.—Upon the map which accompanies this report, I have drawn profiles of the tidal curves for Cotamy, inside and outside, so that one with his eye may see how sharp the contrasts of the tides appear on the two sides of this beach, and how much the relative levels differ. Not trusting any single day's work, however, but going back to the whole series, I give below a table of average conditions.

Time.

Cotamy Bay, at the same level as the sea outside (before moon's transit),	2h. 32m.
High water in Cotamy Bay (after moon's transit),	0h. 28m.
Greatest height of Cotamy Bay above the sea outside (after moon's transit),	0h. 40m.
Cotamy Bay again at same level as the sea outside (after moon's transit),	4h. 40m.

Difference of Level.

Maximum height of Cotamy Bay above the sea (after the larger high water),	1.36 feet.
Maximum height of Cotamy Bay, above the sea outside, during a N.E. gale of ordinary violence,	1.83 feet

The times of the preceding table, which are counted from the moon's transit, (i. e. from her southing or northing) are subject to

variations of about forty minutes either way. It will be safe, however, to provide for throwing open the canal two hours before the time of transit given in the almanac.

Those differences of level only are given in our table which favor the outflow, and those only which follow after the *larger* of the two tides which occur upon the same day. Care should be taken to select this larger tide, and this may be done by referring to the heights at Boston, given in the tide-tables of the Coast Survey for every day of the year. The differences of height do not increase very much from neaps to springs, but as the opening is to be made (according to our presumption) about the time of high water, there will be a saving of labor by selecting a period of high tides. There will also be a decided advantage in selecting a period of strong winds, from north to east, but winds from the opposite quadrant will prove very unfavorable. During the period when the surface of Cotamy Bay is above that of the ocean, i. e. from 2h. 32m. before till 4h. 40m. after the transit, the current runs southward through Muskeget Channel, and sometimes feebly to the westward along the outside shore of Cotamy Beach,—but the prevailing stream along this shore sets to the eastward within the Wasque Shoal.

The currents of Edgartown Harbor underwent an important change of regimen when the opening through the south beach closed. Lieutenant Davis' observations in 1847 showed that the stream commenced to run *northward* past the town, and eastward over the bar, two hours before low water, and that it continued to hold the same courses till within two hours of high water. As things are now, the stream begins to run *in* over the bar and *southward* past the town, about the time of low water. It halts, or even turns back for a while, on the fourth hour, then runs up again until near time of high water.

Under the old regimen, much more water flowed northward than ever returned. A glance at the tidal curves, on our sketch, will show how this happened. When the tide was low in Cotamy Bay, it was high in the ocean, so that the inlet and its outer bar channels were broad and deep, admitting a great volume of water. On the other hand, six hours later, when the bay was full, the ocean outside was low, the inlet and outer bar channel were narrow and more shallow, and a comparatively small volume of water could escape to the sea. These were the very conditions best calculated to keep the port free. In my first attempt at anything like a scientific paper, over fifteen years ago, I called attention to the fact that "*about the same relation is preserved between*

the surfaces of the water at Brant Point and Weweeder, as between Cape Poge and Wasque, and all the advantages which the harbor of Edgartown possesses over that of Nantucket would seem to be due to the existence of a southern opening in the former case."

I remember that this was the result of a study made from actual levellings and careful observations, but had no connection, whatever, with any project of improvement at either of these ports.*

The soundings in the harbor of Edgartown, given upon the accompanying chart executed by Mr. Marindin, differ from those which appear upon the chart of Lieut. Chas. H. Davis (dated 1846) in three localities of limited extent.

1st. One foot more water can now be brought into the town basin over the bar.

2d. The apron of sand within Chappaquiddick Point has extended, so as to reduce the depth all the way across the channel, and impair the holding ground. The cross-section most encroached upon, has lost about twenty-five per centum of its area.

3d. An increase of the bulkhead or shoal, in the broadest portion of Cotamy Bay has occurred, and amounts to nearly one million of cubic yards.

From inquiry among the citizens of Edgartown, I learned that the increase of water over the Bar had not been noticed by them, so I conclude that it may be nothing new, but a gradual change of past years. It was quite otherwise with the apron of Chappaquiddick Point, which had excited attention by its recent advances. The shoal in Cotamy Bay has undergone so many modifications of form within the memories of pilots and boatmen, that their testimony was uncertain. Until we can have still another survey, we must infer that the two years closure of the beach has not affected the bar or bay, but has conduced to the shoaling of the main channel, and has greatly reduced its width at one point. What this change portends I do not dare predict, but I agree with the good people of Edgartown in thinking that something ought to be done to stop it forthwith.

Nantucket Harbor.—In the table which follows I give the elements of the tides at all the stations occupied by my party in 1854.

* Annual Report of Coast Survey for 1856. Appendix, No. 37.

Tide Table for Nantucket.

(Averages from long series of observations.)

LOCALITIES.	HIGH WATER.		LOW WATER.		Rise and Fall.
	Occurs before the Moon Souths.		Occurs after the Moon Souths.		
	Hours.	Minutes.	Hours.	Minutes.	Feet.
Smith's Point,	4	38	1	31	2.24*
Weweeder,	4	20	1	49	1 50*
Siasconset,	0	44	5	20	2.10*
Great Point,	0	18	5	36	3.44
	After the Moon Souths.				
Brant Point,	0	13	6	3	3.07
Commercial Wharf, . . .	0	20	6	6	3.00
Head of harbor, . . .	1	2	7	51	3.17†

It will be observed that between Siasconset and Great Point, the tides belong to the eastern system but are not free from the admixture of the western system which prevails as far as Weweeder. The tide of Nantucket harbor also belongs to the eastern system, so that we have on either side of the Haulover modifications of the same tide wave, and not distinct tidal systems as at Cotamy on Martha's Vineyard. The delay, however, and the distortion of profile, which the tide undergoes in its passage to the Upper Harbor, gives rise to a considerable contrast of elevation on the two sides of the Haulover—amounting to over one foot at the time of maximum difference, an hour after the low water, and two hours after the high water of the Upper Harbor. From the best that I can do with computations from stations so distant from the scene, I should say that from the time of high water (in the Upper Harbor), until within two hours and a half of low water, the surface of the Upper Harbor is above that of the ocean. For some little time before high water the stream would be continuous through the narrows into the Upper Harbor, and out through the inlet to the sea. The reverse would be true at low water. It will be very easy from a few observations on either

* Outside Stations.

† Inside of Haulover.

side of the Haulover, before the cut is made, to determine more exactly the relations upon which I now speak so timidly.

By connecting the observations of a few days with the benches of my long series at other points, the proper moment for throwing open the communication may be predicted with certainty in terms of *interval after the transit of the moon*. The movement into the basin from outside will exceed in velocity that which, six hours later, will obtain in the opposite direction; so that an interior accumulation of sand will be likely to occur, as well as a bar outside. The basin of the upper harbor is, however, deeper than any other part of the port, and not, as now, used for commercial purposes.

The coastwise streams are strong at Siasconset and at Great Point, but off the Haulover the current is quite feeble. Capt. George W. Coffin of Siasconset made observations upon the currents at several points along the eastern shore of the island in 1855, when employed in my surveying party, and it is to his data that I have referred.

There are few cases where a community has less to lose from the failure, or more to gain by the success of an experiment. A passage-way through the beach would build up the fishing interests of the place; it would also be an avenue for pilots carrying hope and assistance to vessels bewildered among the shoals, and for life-boats bound on errands of mercy.

It is five and a half nautical miles from the Haulover to the north end of the Bass Rip; it is now over sixteen miles to the same point by the shortest water route from the Brant Point entrance.

Vineyard Haven.—Upon the resurvey of this anchorage I shall report hereafter. Mr. Marindin's work bears every evidence of care, and the preceding survey seems to be good; so that the results from comparison ought to be valuable and interesting.

§ 3. *Elements of the Field-work.*—In the harbors of Edgartown and Vineyard Haven, there were executed one hundred and thirty-nine linear miles of soundings, containing a total of 20,547 casts of the lead; 2,016 angles were measured, nine current and three tidal stations were occupied. The current observations were taken at different depths whenever the station lay in the channel. The stations in the Sound were occupied for current observations with a view to determine the causes of the remarkable shoal, known as the Hedge Fence. I am not satisfied that we fully understand this shoal yet, so I do not report upon it.

The bench of our survey, at Edgartown, is the outer edge of the *water-table* (or set-off at top of stone foundation), under the window on the right hand side on entering the front door of the Martha's

Vineyard National Bank. Mean-low water, as observed upon our gauge at Town Wharf (about 500 feet distant), is 15.16 feet below this bench, high water 13.16 and the highest storm tide of the last twenty years (with wind E. S. E.), 10.50. The storm tide referred to, was observed by Mr. Dunham in November, 1871. It rose about two-tenths of a foot higher than a previous remarkable rise observed by him many years ago. The tide of Cotamy Bay, since the closing of the beach, has the same form as that at the Town Wharf, but occurs about a quarter of an hour later.

I have made two visits to Nantucket, in the first of which I procured the three sections at the Haulover, the mean of which appears upon our chart. The second visit was fruitless by reason of a snow-storm which interrupted operations.

Before closing this report I ought to call your attention to the hydrography executed by my excellent assistant H. L. Marindin, which is good. Acting under my advice he did not cover the ground equally, but expended the most labor where most useful.

The previous chart of Lieut. (now Rear-Admiral) Davis, although made in the early days of our service, has furnished a secure base of comparison. Over a large part of the field the two surveys agree, and where this is not the case, the causes of change have been investigated, and close work executed. Mr. F. H. North served as aid upon the work, and was engaged upon currents and tides. Messrs. Lincoln Cabot and W. E. Sparrow, students of the Massachusetts Institute of Technology, and Mr. S. G. Pendleton, student at the Rensselaer Institute at Troy, lent their aid to us during the vacation, and did very good service with very good will.

Very respectfully submitted.

HENRY MITCHELL,

U. S. C. S.

To Prof. BENJAMIN PEIRCE, *Superintendent U. S. Coast Survey.*

OPINIONS OF U. S. ADVISORY COUNCIL UPON EDGARTOWN AND NANTUCKET HARBORS.

1st.—*On the proposed reopening of the Southern Inlet to Edgartown Harbor.*

The recent sanding up of the opening through Cotamy Beach deprives the harbor of Edgartown of that tidal circulation upon which has depended, we confidently assert, the maintenance of the fine channel leading from the outer roadstead to the perfectly sheltered basin near the town. Should the beach remain closed, we

have no doubt that this channel will be injured and a valuable national harbor of refuge deprived of one of its greatest advantages. Except Wood's Hole, which is at times difficult of access, this is the only perfectly safe port between Provincetown and Newport. The regimen of the currents has wholly altered since the inlet closed, and an accumulation of sand actually commenced opposite the town.

An acquaintance with the hydrography of the neighborhood, at times very intimate, during a quarter of a century, discovers to us no fundamental changes in the physical conditions, and we believe that with the artificial opening of the inlet, nature will at once respond to the efforts of the engineer, resume her good offices, restore the former regimen of the currents, and maintain, perhaps for years, all the advantages that have distinguished this harbor. That the new inlet will repeat the history of those which have before existed, shifting eastward and ultimately closing, we do not doubt, but the remedy may always be repeated and will never be expensive.

2d.—Proposed opening through the Haulover at the head of Nantucket Harbor.

This experiment we hope to see tried; and while we should expect no great effect upon the bar at the main entrance, even if the opening at the Haulover should be maintained, we can anticipate only benefits.

The relation of the tides upon the two sides of the beach, here, are quite unlike those at Cotamy, the contrasts of water levels at the different tidal stages being considerably less. The seaward exposure is greater, yet the supply of material due to the waste of the headlands has of late years been less upon the eastern shore of Nantucket than upon the south side of Martha's Vineyard.

We repeat that the experiment at the Haulover is worth an earnest trial and that some benefit elsewhere, but no injury anywhere, may be anticipated.

We have purposely avoided entering into details in giving the above opinions. These details however will be placed at your disposal in the form of papers and reports from the Coast Survey officers, bearing dates from 1846 to 1871.

C. H. DAVIS,

R. A. U. S. N.

BENJAMIN PEIRCE,

Supt. U. S. Coast Survey.

HENRY MITCHELL,

U. S. Coast Survey.

Commonwealth of Massachusetts.

In the Year One Thousand Eight Hundred and Seventy-Two.

AN ACT to establish certain Harbor Lines on Wareham River.

Be it enacted, &c., as follows:

SECT. 1. No wharf, pier or other structure, shall be extended into or over tide water in Wareham River from the westerly bank of said river beyond the line hereinafter defined on the westerly side of said river or from the easterly bank of said river beyond the line hereinafter defined on the easterly side of said river.

The line on the westerly side of Wareham River begins at a point on the low-water mark on the easterly side of the embankment of the Cape Cod Railroad, in line with the present face of the old wharf between the town bridge and the said railroad embankment extended, marked A on the Harbor Commissioners' map of Wareham River, dated January 1st, 1872, and runs south-easterly following and coinciding with said line of said old wharf extended, and the line of said old wharf, the westerly abutment of the town bridge and the line of the Agawam wharf, south of the town bridge, to the first re-entering angle in said line of said Agawam wharf, distant about 260 feet south-easterly from the southerly side of the said town bridge at a point marked B on said map; thence turning more easterly and running in a straight line a distance of about 300 feet to the present northerly end of the sea-wall on the line of the wharf of the Parker Mills Company to a point marked C on said map; thence turning and running more southerly, following and coinciding with the lines of the said wharf of the Parker Mills Company and the wharf of the Franconia Mills Company to the south-easterly corner of the sea-wall or wharf of the said Franconia Mills Company to a point marked D on said map; thence continuing south-easterly in the same direction as the last-named line a distance of 600 feet to a point marked E on said map; thence turning more southerly by an angle with the last named line of $17^{\circ} 40'$ and running a distance of 600 feet to a point marked F on said map; thence turning still more southerly by an angle with the last named line of $17^{\circ} 40'$ and running a distance of 600 feet to a point marked G on said map; thence turning south a little westerly by an angle with

the last named line of $10^{\circ} 00'$ and running a distance of 1,580 feet, to a point near the entrance of the small channel running into Broad Marsh River, so called, marked H on said map; thence turning north-westerly by an angle with the last named line of $64^{\circ} 00'$ and running a distance of 500 feet to a point marked I on said map.

The line on the easterly side of Wareham River begins at a point on the outer or south-westerly corner of the stone abutment or seawall, on the southerly side of the sluice or passage-way for barges under the town and railroad bridges marked K on said map; and runs south-easterly in a straight line a distance of 1,085 feet to a point opposite the wharf of the Franconia Mills Company on the westerly side of the river, and distant from the line of said wharf 250 feet measuring from a point opposite the north-easterly corner of the main foundery building on said wharf marked L on said map; thence turning more easterly by an angle with the last-named line of $16^{\circ} 00'$ and running a distance of 1,400 feet to a point marked M on said map; thence turning southerly by an angle with the last named line of $12^{\circ} 00'$ and running a distance of 300 feet to a point marked N on said map; thence turning more southerly by an angle with the last-named line of $27^{\circ} 30'$ and running a distance of 300 feet to a point marked O on said map; thence turning more southerly by an angle with the last-named line of $23^{\circ} 00'$ and running a distance 300 feet to a point marked P on said map; thence turning south a little westerly and running a distance of 2,000 feet to a point distant about 75 feet westerly from the high-water mark at the salient point of the headland on the easterly side of the river, opposite the mouth of Broad Marsh River, on the westerly side of the river, marked Q on said map, which point Q is distant 500 feet from the line GH, on the opposite and easterly side of the river, measuring at right angles to said line GH.

SECT. 2. Nothing contained in this act shall be construed to give authority to any person to extend or construct a wharf, pier or other structure in Wareham River.

SECT. 3. This act shall take effect upon its passage.

COMPENSATION.

Inquiry of the Harbor Commissioners. Reply of the United States Advisory Council.

Voted, That the Advisory Council be requested to state to the board their judgment as to the importance and expediency of applying the principle of compensation to the upper harbor of Boston, as prescribed in section 4 of

chapter 149 of the Acts of the legislature of Massachusetts for 1866, and whether and to what extent any investigation made since the reports of the United States Commissioners to the city of Boston, and particularly the investigations mentioned in the report of the Advisory Council to this Board, appended to the report of this Board to the legislature of 1868, have modified the basis upon which the principle of compensation has been maintained.

To the Harbor Commissioners, State of Massachusetts, City Hall, Boston.

GENTLEMEN :—The Advisory Council has had under consideration the vote of inquiry addressed to it on the 4th instant by the Harbor Commissioners, and has the honor to submit the following report: The vote comprises two interrogatories—one relating to compensation in the upper harbor, the other to a supposed modification of the basis upon which the principle of compensation has been maintained. They will be best answered separately.

First. We, the members of the Council, agree unreservedly and unanimously in the opinion that it is important and expedient to apply the principle of compensation to the upper harbor of Boston.

We say this, not only without qualification, but we go farther and say that not to apply it to the upper harbor is to abandon it altogether, and to lay the harbor open to encroachment, by which it may be seriously injured, and its commercial instrumentality consequently impaired.

The upper and lower parts of a tidal harbor, such as we have often described that of Boston to be, may each be regarded as the exponent of the other, and as the value of the exponent varies, a corresponding change takes place in the value of the whole quantity. If we permit ourselves to conceive it possible that during the past two centuries there should have been such a strict and uniform application of the rule of compensation, based upon the cost of restoring an equivalent amount of tide-water by excavation; that every infringement upon the water-space in one place should have been fully counterbalanced by an improvement in another and suitable place, we have reason to believe that the channels and roadsteads of the harbor would be in as good condition now as at the period of the foundation of the city. And in the same manner, dismissing the past and starting from the present period, and the existing condition of things, if we desire to preserve the harbor as it is for the use and benefit of posterity, we must adhere strictly and faithfully to this vital principle. Thus it appears we not only do not abandon the application of the principle of compensation to the upper harbor, but we wish to enforce it with the whole weight of our authority.

But this fundamental law of conservation, from which are derived so many minor modes and rules of proceeding in the theory and practice of engineering in tidal harbors, may be put in practice in various ways.

In ambiguous cases it is always prudent to take the advice of a professional student of physical hydrography. But whatever may be the peculiarities of any given case, and however doubtful may be the expediency of an immediate local application of the law *in kind*,—doubtful, that is, in respect to time and place,—there is one course previously recommended by us, that may always be followed with safety; that is, to take compensation in money, to be expended under the authority of the Commissioners, for the restoration of water-space, or in the application of equivalent preservative power, and the removal of injurious accumulations whenever and wherever they are most necessary.

A tidal harbor, the shores of which have long been the seat of the wharves, warehouses, bridges, railroads, ship-yards, workshops and manufactories of a very large and very active commercial population, is like all other things in use, undergoing processes of deterioration that ought to be arrested and diverted as they show themselves and become hurtful. It is to be remembered that every case is not as clear as that of South Boston flats, where the grant lies on one side of the wall and the means of restitution on the other. In general, where water-space has been conceded, it is sufficient if the means are retained for repairing the consequent loss; but the time, the mode, the place of this reparation, may be subjects for future determination. As the agents for deterioration are diverse and complicated in their nature and action, so also are they in their results.

In some cases the relations of causes and effects are obvious; in others they are traced with difficulty. The former may receive almost instant remedy, such as has been applied to the continual growth of the shoals and spits in the lower harbor, caused by the degradation of the exposed bluffs of the outer islands.

On the other hand, the plan of improvement of the south shore of the inner harbor was the result of an investigation, long, manifold and laborious. The advantage of the compensation fund lies in this: that it can be universally applied. And it is to be used by intelligent persons, who have made a study of the whole scheme of the waters combined to form the harbor, and who are furnished with the best information by experts, by local residents, by projectors, and by able engineers and hydrographers. Since this may be our last occasion of addressing the Commissioners on the subject of

compensation, we venture to urge, with all becoming earnestness, the importance and duty of exacting from all persons and corporations deriving benefits from filling up the flats and tidal mud-lands in any part of the harbor a moderate compensation for their concessions, and this we do for their own as well as for the general ultimate good.

Second. We reply to the second inquiry by saying that no investigation made since the report of the United States Commissioners to the city of Boston, including the investigations mentioned in the reports of the Advisory Council to your Board, appended to your report to the legislature of 1868, have modified the basis upon which the general principle of compensation has been maintained.

The report of the Council here referred to is limited in its subject and its scope to the part of the upper harbor exhibited in the diagram which accompanied it. It is a statement of facts and figures covering local changes, and its deductions are inferences from those changes. But these deductions are not intended to be received as generalizations. The rapidity of a current, and its consequent capacity for work, may be increased by two causes: one, the enlargement of the reservoir without change in the channels; the other, the contraction of the channels with an undiminished reservoir.

The latter changes may proceed so far as to make an immediate increase of the interior water undesirable, on account of excessive scour, and on account of inconvenience to navigation. But such a condition would not furnish an argument against the truth and utility of the principle of compensation. The shifting of the bottom, in that portion of the upper harbor which was under examination, was caused by encroachment.

The Council did not then follow up the further consequences of these encroachments. A consideration of the loss of tidal volume between the periods of the surveys, which supplied the means of comparison, formed no part of that brief discussion.

C. H. DAVIS, *Rear-Admiral, U. S. N.*

A. A. HUMPHREYS, *Br. and Bt. Gen'l, U. S. A., Chf. of Eng'rs.*

BENJAMIN PEIRCE, *Supt U. S. Coast Survey.*

HENRY MITCHELL, *U. S. Coast Survey.*

U. S. Adv. Council to B'd of Harbor Commis'rs of Mass.

FEBRUARY 27, 1871.

Commonwealth of Massachusetts.

In the Year One Thousand Eight Hundred and Seventy-Two.

AN ACT

To regulate the building of Wharves and other Structures in tide-waters.

Be it enacted, &c., as follows :

SECT. 1. Any person may build or extend any wharf or construct any pier, dam, sea-wall, road, bridge or other structure, fill any land or flats, or drive any piles in or over tide-water below high-water mark within the line of riparian ownership, on any shore, and within whatever harbor lines there may be at the time established by law along such shore ; *provided*, the license of the board of harbor commissioners is first obtained in the manner provided by the fourth section of chapter one hundred and forty-nine of the acts of the year eighteen hundred and sixty-six.

SECT. 2. The board of harbor commissioners is hereby authorized to license any person to build or extend any wharf, construct any pier, dam, sea-wall, road, bridge or other structure, or fill any land or flats in or over tide-water, below high-water mark and beyond the line of riparian ownership, upon such terms as they may prescribe : *provided, however*, that no such license beyond the line of riparian ownership shall be valid, unless approved by the governor and council ; and *provided, further*, that no such license on any shore shall have any effect beyond such line of riparian ownership, except where a harbor line has been established by law along such shore ; and no such license shall have effect beyond such line, except in relation to a structure authorized by law outside such line.

SECT. 3. Every license granted under this act or under the fourth section of chapter one hundred and forty-nine of the acts of the year eighteen hundred and sixty-six, shall be signed by majority of the commissioners, and shall set forth the terms of the same and specify by metes, bounds and otherwise, so as to identify and define, the location, dimensions, limits and mode of performing whatever is authorized by said license ; and said commissioners shall cause a certified copy of the same, together with a correct plan of the authorized work or structure to be recorded in books kept for that purpose in the office of said board.

SECT. 4. Licenses granted as herein provided shall be subject to the provisions of chapter one hundred and forty-nine of the acts of the year eighteen hundred and sixty-six, and chapter four hundred and thirty-two of the acts of the year eighteen hundred and sixty-nine so far as applicable and not inconsistent with this act; and every license hereafter granted by said board shall be void, unless the same and the accompanying plan are recorded within one year from the date thereof, in the registry of deeds for the county or district within which the work licensed is to be performed. But nothing contained in this act shall be construed to apply to the back bay lands, so called.

Erratum.—On the 63d page, 2d line from the bottom, for “distributed” substitute *undisturbed*.

